

VIRGINIA DIVISION OF GEOLOGY AND MINERAL RESOURCES

DIGITAL REPRINT OF
GEOLOGY AND
MINERAL RESOURCES OF
ALBEMARLE COUNTY

Wilbur A. Nelson

BULLETIN 77

Adobe Acrobat® Reader®

Adobe Acrobat Reader version 5.0 or later is required to view this document. To obtain a copy of this software from the Adobe® website visit <http://www.adobe.com>.

Limitations on document use

The purpose of the digital rendering of Geology and Mineral Resources of Albemarle County by Wilbur Nelson is to make accessible an out of print work. The document was scanned and optical character recognition (OCR) performed. However, all text generated by the OCR process has not been checked for accuracy. The original scan is the background for the document. Therefore, pages may read and print correctly, but “cut and paste” procedures may produce text which does not match the text shown by the image (page) being viewed.

Bookmarks

Bookmarks should be enabled when the document opens.

If bookmarks are not visible, in Acrobat Reader 5.0:

- On the main menu select Window, Bookmarks
- or
- press the F5 key

A check mark will appear to show the bookmark pane is viewable.

Virginia Department of Mines, Minerals and Energy
Division of Geology and Mineral Resources
900 Natural Resources Drive, Suite 500
Charlottesville, VA 22903



COMMONWEALTH OF VIRGINIA
DEPARTMENT OF CONSERVATION
AND ECONOMIC DEVELOPMENT
DIVISION OF MINERAL RESOURCES

GEOLOGY AND MINERAL RESOURCES OF ALBEMARLE COUNTY

Wilbur A. Nelson

BULLETIN 77

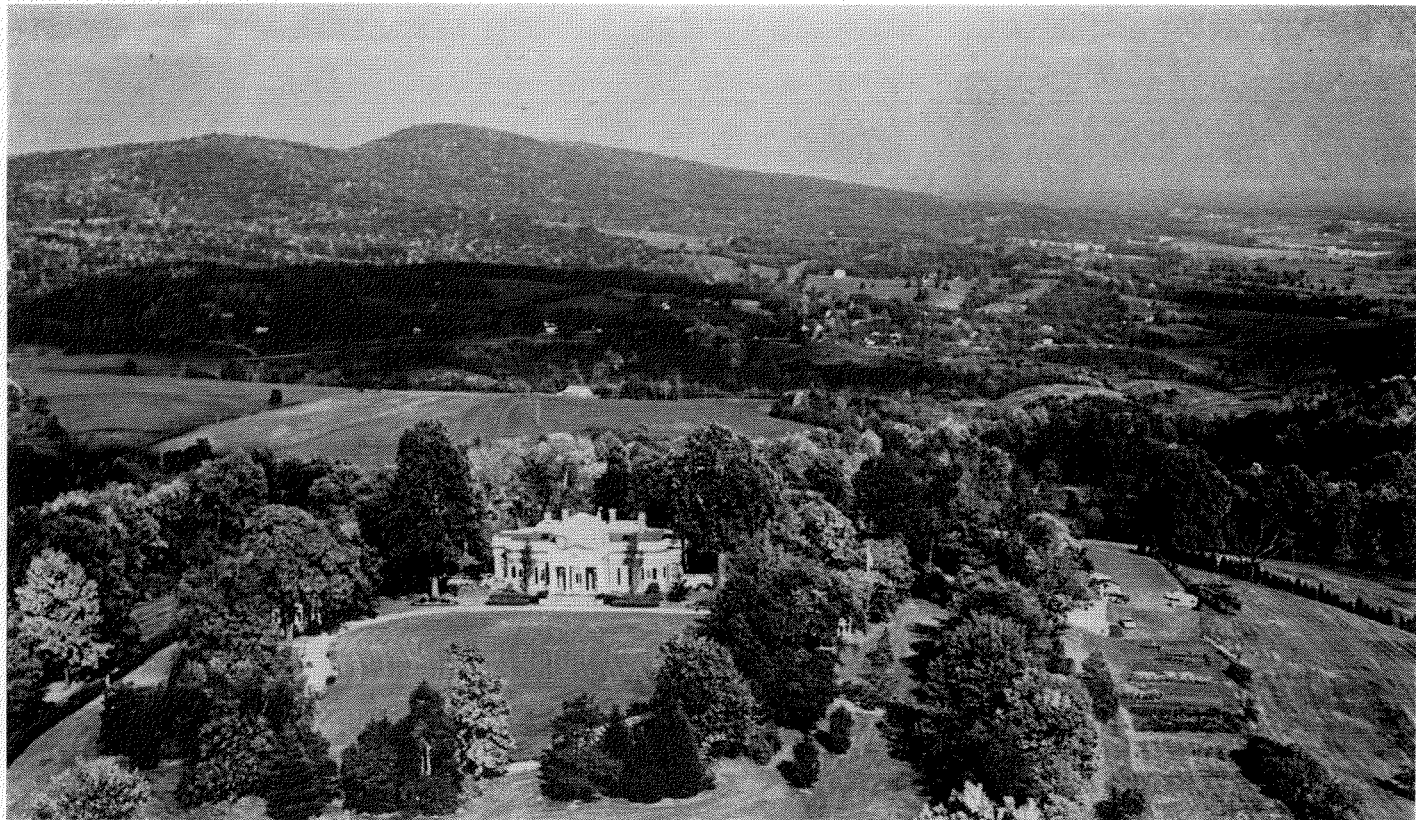
VIRGINIA DIVISION OF MINERAL RESOURCES

James L. Calver

Commissioner of Mineral Resources and State Geologist

CHARLOTTESVILLE, VIRGINIA

1962



Thomas Jefferson Memorial Foundation

MONTICELLO

Looking northeast toward Southwestern Mountain

DEPARTMENT OF CONSERVATION AND
ECONOMIC DEVELOPMENT

Richmond, Virginia

MARVIN M. SUTHERLAND, *Director*

A. S. RACHAL, JR., *Executive Assistant*

BOARD

G. ALVIN MASSENBURG, Hampton, *Chairman*

SYDNEY F. SMALL, Roanoke, *Vice-Chairman*

A. PLUNKET BEIRNE, Orange

C. S. CARTER, Bristol

WORTHINGTON FAULKNER, Glasgow

GARLAND E. MOSS, Chase City

VICTOR W. STEWART, Petersburg

ERWIN H. WILL, Richmond

WILLIAM P. WOODLEY, Norfolk

COMMONWEALTH OF VIRGINIA
DEPARTMENT OF PURCHASES AND SUPPLY
RICHMOND

1962

PUBLISHER'S NOTE

This bulletin was undertaken by Wilbur A. Nelson, Corcoran Professor Emeritus of Geology, to popularize the geology of Albemarle County. It is written in a non-technical manner for the people of Virginia and Albemarle County. Professor Nelson is well acquainted with the entire geologic history of Virginia and his descriptive style will be recognized by his colleagues and former students.

—J. L. C.

CONTENTS

	PAGE
Preface	
Abstract	1
Introduction	4
Location	4
Transportation	5
Culture	5
Geography	6
Purpose	7
Previous work	8
Field work and acknowledgments	9
Geological formations	11
Introduction	11
Pre-Cambrian System	11
Lovingston gneiss formation	11
Virginia Blue Ridge complex	15
Rockfish conglomerate formation	17
Lynchburg gneiss formation (restricted)	19
Johnson Mill graphite slate formation	21
Charlottesville formation	22
Cambrian or Precambrian system	22
Swift Run formation	22
Mechum River formation	24
Catoctin formation	24
Loudoun (Unicoi) formation	28
Cambrian system	30
Harpers shale (Hampton shale)	30
Erwin quartzite formation (Antietam sandstone)	30
Everona limestone formation	31
Triassic system	32
Triassic rocks	32
Cambrian and Precambrian contact	35
Igneous rocks	37
Tabular shaped bodies	37
Alaskite dikes	37
Amphibolite dikes	37
Diabase dikes	38
Feeder dikes	40
Felsite dikes	40
Gabbro dike	41
Metapyroxenite dikes	42
Light colored amphibolite dike	42

	PAGE
Structure	43
General statement	43
Southwestern Mountain-Blue Ridge anticlinorium	43
Everona syncline	46
Faults	47
High angle thrust fault	48
Border fault	48
High angle reverse faults	48
Normal faults striking northeast and southwest	51
Normal faults striking northwest and southeast	52
Normal tension faults extending in a north-south direction	52
Normal faults having an almost east-west strike	53
Mechum River graben	53
Angular unconformities	53
Schistosity and gneissic structure	55
Augen gneiss	55
Fracture cleavage	55
False cleavage	56
Mullion structure	56
Normal fault shear zone	56
Joints	57
Geologic history	60
Mineral deposits	64
Amethysts	64
Asbestos	64
Barite	64
Brick	64
Brick clays	64
Building stones	65
Stony Point copper mine	66
Crushed stone	66
Fluorspar	67
Garnets	67
Gold	67
Graphite deposits	67
Iron ores	69
Cook Mountain magnetite deposits	69
Limonite deposits	69
Specular hematite	70
Stony Point mine	70
Limestone quarries	70
Pyrite mine	71
Sand	74
Slate deposits	75
Esmont slate quarry	75

	PAGE
Soapstone and serpentine	76
Zinc and lead deposits	78
Ground water	80
Blue Ridge physiographic province	80
Piedmont physiographic province	80
Virginia Blue Ridge complex	80
Virginia Blue Ridge complex with infolded Swift Run	80
Mechum River slate belt	81
Lovingston gneiss	81
Rockfish conglomerate formation	81
Lynchburg formation	81
Johnson Mill formation	81
Charlottesville formation	81
Swift Run formation, eastern belt	82
Catoctin greenstone	82
Loudoun formation	82
Everona limestone formation	83
Triassic area	83
Diabase and amphibolite dikes	83
References	84
Index	89

ILLUSTRATIONS

PLATE	PAGE
1. Geologic map of Albemarle County, Virginia.....	<i>In pocket</i>
Monticello, looking northeast toward Southwestern Mountain.....	<i>Frontispiece</i>
FIGURE	
1. Index map showing location of Albemarle County.....	4
2. View from Superior Stone Company's quarry, showing Ragged Mountains in the background.....	7
3. A split spheroidally weathered boulder of Virginia Blue Ridge complex at dam of Charlottesville's reservoir on Moormans River, approximately 4.5 miles west of White Hall.....	16
4. Rockfish conglomerate at type locality (Nelson County) 800 feet above unconformity between Rockfish conglomerate and Lovington gneiss.....	17
5. Basal 100 feet of Rockfish conglomerate at type locality, Nelson County.....	18
6. Rockfish conglomerate on State Road 774 about 1.5 miles northeast of Faber	19
7. Banded Lynchburg gneiss at north end of Barracks Road Shopping Center, Charlottesville, Minor faults are also evident.....	20
8. Columnar jointing in Catoctin formation on Blue Ridge Parkway, 1.8 miles south of Rockfish Gap.....	26
9. Greenstone conglomerate near top of Catoctin formation near Keswick.....	27
10. Gash veins in epidotized quartzitic sandstone in the base of the Unicoi formation on U. S. Highway 250 just west of Rockfish Gap.....	28
11. Nearly flat-lying beds of Everona limestone in Everona syncline exposed in Garland Quarry on State Highway 53 near Buck Island Creek.....	31
12. Fox Mountain dome, looking north from White Hall.....	44
13. Development of complex faults in Barracks Road Shopping Center.....	49
14. Fault exposure at north end of Barracks Road Shopping Center, Charlottes- ville. Location of fault exposure noted on Figure 13, third stage.....	50
15. Five foot displacement of terrace gravel in Pleistocene fault at Lebanon Church on U. S. Highway 250 south of Greenwood.....	51
16. One of a series of faults in shear zone at intersection of U. S. Highway 29 and U. S. Highway 250 Bypass, Charlottesville.....	56

FIGURE	PAGE
17. Charlottesville Stone Company's quarry in the Catoctin formation near Shadwell	66
18. Superior Stone Company's quarry, Red Hill, Virginia.....	68
19. Location of self-potential and magnetic profiles adjacent of Ohio Sulfur Mining Company's mine, near Proffit.....	72
20. Profiles of traverse O, S.45°E.....	73
21. Profiles of traverse 3S, S.45°E.....	73
22. Profiles of traverse 6S, S.45°E.....	74
23. Related self-potential profiles over abandoned pyrite mine near Proffit.....	75
24. Serpentine quarry of Alberene Stone Division of the Georgia Marble Company	77

TABLE	PAGE
1. Geologic formations of Albemarle County.....	12

GEOLOGY AND MINERAL RESOURCES OF ALBEMARLE COUNTY VIRGINIA

By
WILBUR A. NELSON

ABSTRACT

Albemarle County is near the central part of Virginia on the western edge of the Piedmont Physiographic Province. It has an area of 735 square miles. The northwestern edge of the county follows the crest of the Blue Ridge Mountains. The southern edge is at the James River. It is bounded on the north by Greene and Orange counties, on the east by Louisa and Fluvanna counties, on the south by Buckingham County and on the west by Nelson and Augusta counties.

Albemarle County is covered by rocks which, in its western half, are primarily igneous and metamorphic in character. The eastern part of the county is covered by sedimentary and igneous rocks which have been subjected to different degrees of metamorphism. Throughout the county the rocks outcrop in broad belts extending in a northeast-southwest direction.

The major structural feature is the Southwestern Mountain-Blue Ridge anticlinorium. This is a great recumbent anticlinorium with drag folds, bounded on the east by Southwestern Mountain, composed of Catoctin greenstone, and on the west by the Blue Ridge Mountains, composed, in part, of overturned Catoctin greenstone. This anticlinorium is very complex in its structural features. It is bisected by the Mechum River graben, a down-faulted belt of metamorphosed rocks, composed of the Rockfish conglomerate, the Lynchburg gneiss, the Charlottesville formation, and the Swift Run formation, designated in this report as the Mechum River formation.

Between the belt occupied by the Mechum River formation and the Blue Ridge Mountains occurs a belt of igneous and metamorphic rocks,

designated as the Virginia Blue Ridge complex, composed of granodiorite with associated hyperstene granodiorite and granite injections. In the northwest part of the county these rocks form a great dome, named the Fox Mountain dome, surrounded by narrow infolded belts of the Swift Run formation.

East of the belt occupied by the Mechum River formation occurs the Lovingston gneiss, known as the basement complex, overlain by the Rockfish conglomerate, the Lynchburg gneiss (restricted), the Johnson Mill graphite slate, the Charlottesville formation and the Swift Run formation which is at the base of the Catoclin greenstone.

The Catoclin greenstone and the Swift Run formation are considered to be younger than Precambrian in age.

The Virginia Blue Ridge complex, in the western part of the county, and the Charlottesville formation, in the eastern part of the county, are considered to be the top of the Precambrian series of rocks.

The rocks deposited on the Lovingston basement complex total over 60,000 feet in thickness and were deposited in a great Precambrian geosyncline which extended up into Cambrian time. It was first folded into an anticlinorium in Ordovician time, and refolded finally at the close of the Appalachian revolution (Permian time).

To the east of Southwestern Mountain there occurs a belt of sedimentary rocks composed of the Loudoun formation and the Everona limestone, both of Cambrian age. They occur in a synclinal fold roughly parallel to the axis of Southwestern Mountain. The center of this syncline is occupied by the Everona limestone.

On the northern edge of the county, just west of Southwestern Mountain, the southern edge of the Culpeper Triassic basin extends a fraction of a mile into the county. In the southern part of the county, just east of Green Mountain, there occurs the Scottsville Triassic Basin which covers much of the southern part of the county between Howardsville and Green Mountain.

Numerous diabase dikes of Triassic age occur throughout the entire county, with a general north-south direction. Metapyroxenite dikes altered, in places, to soapstone and serpentine occur from the south border to the north border of the county between Southwestern Mountain and the Mechum River graben. Felsite dikes occur around Charlottesville and north into Greene County. Alaskite dikes occur near Monticello, and on Highway 20 one-half mile south of Carter Bridge. Numerous amphibolite

dikes occur in the county. They are composed of crystalloblastic rocks consisting mostly of amphibole and plagioclase; a light colored amphibolite dike occurs near Mayo Chapel just south of Charlottesville.

The fault pattern is rather complex. A major high angle thrust fault roughly parallels the crest of the Blue Ridge along the northwestern part of the county. A border fault occurs along the eastern edge of the basement complex which is the Lovington quartz monzonite. This fault has cut out, in places, part or all of the Rockfish conglomerate. It is a high angle thrust fault dipping steeply to the west. A belt of complex faulting several miles wide extends eastward from the border fault. The faults paralleling the border fault are both reverse and normal faults. Intersecting these faults at almost right angles are a series of parallel faults running northwest and southwest which offset the border fault and the faults parallel to it. Just north of the intersection of Barracks Road with Highway 29 these northwest-southeast faults are closely spaced for 1800 feet and form a shear zone. The Rivanna River cuts through Southwestern Mountain in part of this shear zone.

The most important mineral resources are the soapstone and serpentine quarries along the Nelson-Albemarle County line, extending northward to Alberene. Other quarries produce crushed stone for construction purposes. Building sand is obtained from the Rivanna River near Charlottesville. There is an abandoned lead-zinc mine near Faber and an abandoned iron-copper mine near Stony Point. An abandoned magnetic iron ore mine near North Garden furnished ore to the nearby Olds furnace before Revolutionary times. An abandoned graphite mine is near Nortonville. There are several abandoned slate quarries in the Blenheim area east of Southwestern Mountain. A number of abandoned limestone quarries occur in the eastern part of this county, in the Everona limestone belt. This limestone was used formerly in making lime for agricultural use, and mortar in the construction of the original buildings at the University of Virginia. Residual clays in Charlottesville were used in making the brick for the original Jeffersonian buildings at the University of Virginia. Later a brick plant operated in Charlottesville until 1944. Clays, which are suitable for making brick, occur around Crozet and Keswick.

Ground water resources in most of the county are from fair to good, depending on the geology and topography.

INTRODUCTION

LOCATION

Albemarle County is located in central Virginia just east of the Blue Ridge Mountains. It has an area of 735 square miles. It is bounded on the north by Greene and Louisa counties, on the east by Louisa and Fluvanna counties, on the south by Buckingham County and on the west by Nelson and Augusta counties.

Topographic sheets have been made of all of Albemarle County. The topographic sheets available which cover all or part of Albemarle County are the Elkton, Waynesboro, University, Charlottesville, Covesville and Scottsville sheets, all on the scale of 1 to 62,500, or approximately one inch to the mile, with 20 foot contour intervals except in part of the Blue Ridge Mountains where a larger interval is locally used. A manuscript map of the Trevillians sheet, showing the eastern edge of the county, and a manuscript map of the Howardsville N.W. sheet showing the extreme southern end of the county, both on the scale of 1 to 24,000, were available to the author.

The county seat, and the largest city, is Charlottesville, having a population of 29,427 in the 1960 census. The important towns are Scottsville on the James River and Crozet near the foot of the Blue Ridge Mountains. In addition to these two towns there are many smaller communities, having their own post offices. The county population in the 1960 census was 30,969.

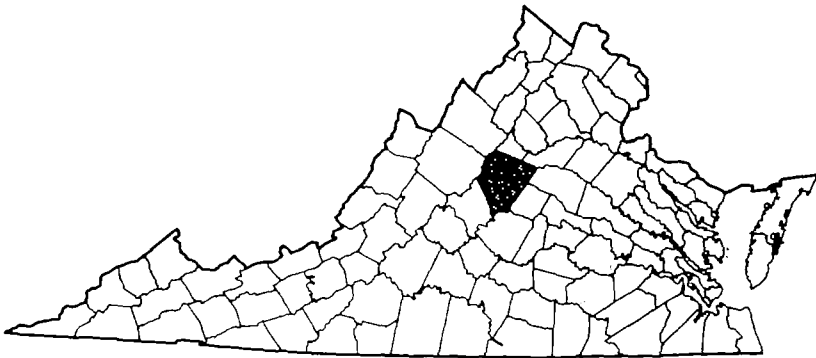


FIGURE 1. Index map showing location of Albemarle County.

TRANSPORTATION

Albemarle County is traversed by two major railroads, the main line of the Southern Railway from Washington to the south and the main line of the Chesapeake and Ohio Railway from Washington to the west.

The main freight line of the Chesapeake and Ohio Railway follows the James River along the southern border of the county and extends from the west to the Port of Hampton Roads. The Chesapeake and Ohio Railway and the Southern Railway cross at Charlottesville.

A network of primary and secondary highways covers the county and provides ready access to all but a few isolated areas at the foot of the Blue Ridge Mountains. The major highways are U. S. Highway 250 from Richmond to the Shenandoah Valley and westward, and Highway 29 from Washington to Lynchburg and south. Primary Highway 20 extends from Barboursville to Charlottesville and from Charlottesville to Scottsville, Highways 22 and 231 from Charlottesville to Gordonsville, Highway 22 from Cismont to Louisa, Highway 53 from Charlottesville to Palmyra, and Highway 6 from Scottsville west to Highway 29. The Skyline Drive follows closely the western boundary of the county, extending from Afton to Front Royal. A large percentage of the secondary highways are paved.

CULTURE

The early history of Albemarle County is best described by the Rev. Edgar Woods (1932).

Albemarle County was formed in 1744 from part of Goochland and Hanover counties and was named from the second Earl of Albemarle, Wm. A. Keppel, who was at that time Governor General of Virginia. It included, at that time, what is now Buckingham, parts of Appomattox and Campbell, and all of Amherst, Nelson and Fluvanna counties. Part of the present Albemarle County, north of a line running past the mouth of Ivy Creek, with the course north 65° west, remained in Louisa County for sixteen years longer. The present boundaries of Albemarle County were established by the Legislature in 1777.

The first land patents, in what was later Albemarle County, were taken out on June 16, 1828, by Geo. Hoomes and Nicholas Meriwether, the former 3,100 acres and the latter 13,762 acres on the lower slopes of Southwestern Mountain which includes today the Castle Hill estate.

The first house built in what is now Albemarle County was near Carter Bridge and was occupied by Joshua Fry before 1744.

Every section of the county has numerous churches.

The entire county, including the incorporated city and towns, has a modern and up-to-date school system.

Many artificial lakes occur in each section of the county, a few of them being open to the public.

Charlottesville and Crozet have municipal parks, and Charlottesville, Scottsville and Crozet have publicly owned water systems.

GEOGRAPHY

Albemarle County lies almost entirely in the Piedmont physiographic province of Virginia, the western edge of the Piedmont province coinciding with the eastern foot of the Blue Ridge Mountains.

The Blue Ridge Mountains, Pasture Fence Mountain and Bucks Elbow Mountain, which form the Blue Ridge physiographic province, are located along the northwestern edge of the county. The maximum elevation is the top of Loft Mountain, 3,250 feet, located in the extreme northwest corner. Typical Piedmont topography occurs from the foot of the Blue Ridge eastward to Southwestern Mountain, an area dotted with mountains of circumdenudation. One such group is the Ragged Mountains south of Charlottesville. Another group is Fox Mountain in the northwest part of the county. The Ragged Mountains have elevations ranging from 1,200 feet to over 2,400 feet and are separated by valleys having elevations from 800 feet to slightly over 500 feet. (Figure 2). The Fox Mountains have a maximum elevation of 2,400 feet.

Southwestern Mountain extends in a northeast-southwest direction almost through the center of the county, with Charlottesville located on its western edge, see Frontispiece. The highest peaks on this mountain vary in elevation from over 1,800 feet to 1,300 feet above sea level. As the mountain extends southwest it is locally known as Carter Mountain and Green Mountain, and gradually loses elevation. It merges into the Piedmont peneplane at the southwestern corner near the town of Schuyler.

The dissected Piedmont plateau which lies east of Southwestern Mountain has an elevation between 500 and 600 feet above sea level, except in the vicinity of the James and Rivanna rivers where this plane varies between 400 and 500 feet in elevation. The lowest elevations are approximately 250 feet above sea level where the Rivanna River crosses the Albemarle-Fluvanna county line and where the James River enters Fluvanna County at Scottsville.



Courtesy of American Marietta Co.

FIGURE 2. View from Superior Stone Company's quarry, showing Ragged Mountains in the background.

Albemarle County is drained by the James River and three of its major tributaries, the Rockfish River, the Hardware River and the Rivanna River and their numerous tributaries. The headwaters of the South Anna River extend into this county a fraction of a mile near Gordonsville. The headwaters of the North Anna River extend into this county over a mile near Barboursville. All of the tributaries of the James River flow in entrenched, meandering channels which cross the structural trend of this area. Their drainage pattern has, in places, a well defined trellis pattern, and in other places a poorly defined pattern of the same type.

PURPOSE

The purpose of this report is to furnish a map of the geology of Albemarle County on a scale of 1 to 62,500, and to give in detail the geology, geological structure and economic geology of the county.

The topographic maps listed on page four of this report were used as the base map for making the geologic map of the county. An index to these quadrangles is included on Plate 1.

PREVIOUS WORK

The earliest geological report covering any part of Albemarle County was made by William Maclure (1817).

The colored geological map accompanying this report shows Albemarle County to be composed of rocks trending northeast and southwest, and belonging to two groups known as primitive rocks and transition rocks. The dividing line, the crest of the Blue Ridge, is described by Maclure as follows:

"Between Magotty Gap (Roanoke County) and Rockfish Gap (edge of Albemarle County) a distance of upwards of 60 miles I (Maclure) found in six different places that were examined, that the summit of the Blue Ridge divided the Primitive and Transition formation."

Previous to the Maclure report an iron furnace was built by Mr. Olds near North Garden and iron ore was mined on Cook Mountain to the west of North Garden. Statements in regard to the operation of the Olds Furnace are contained in "Mineral Resources of Virginia" published by Thomas Watson for the Jamestown Exposition in 1907.

Thomas Jefferson (1787) mentions Olds iron works in Albemarle County as one of the chief iron works in Virginia. He also stated "Marble of very good quality occurs in great abundance overhanging a navigable part of the James at the confluence with the Rockfish in the form of a very large precipice." He also described the Rivanna River as follows: "The Rivanna is a branch of the James River and is navigable for canoes and batteaux to the point where it flows through Southwestern Mountain. It might be easily opened to navigation through these mountains to above Charlottesville at its fork."

The first report of the first geological survey, for the year 1835, by William B. Rogers, Professor of Natural Philosophy at the University of Virginia, was published in 1838 by C. Sherman and Company, Philadelphia. In this report, and the others which followed, reference is made in many places to the geology of portions of Albemarle.

Following Rogers very little geological work was done until, in 1876, Major Jed Hotchkiss published a book in which the mineral deposits of Albemarle County were mentioned. He also edited a monthly magazine "The Virginias", from 1880 to December 1885, which contained several articles giving information on Albemarle County.

Arthur Keith, who first correctly described the Catoctin in the Harpers Ferry Folio, also was the author of "Geology of the Catoctin Belt" published in 1894. After this date a few geologists of the U. S. Geological Survey published reports covering parts of Albemarle County.

One of the first reports with a detailed map of the Triassic areas in this county was by Heinrich (1878).

In 1907, Thomas Watson was the author of "Mineral Resources of Virginia", a compilation of all known data on Virginia's mineral resources. In this book numerous references are made to the mineral resources of Albemarle County.

In 1928 a new geological map of Virginia, compiled by George W. Stose, under the direction of the author who was at that time State Geologist, showed for the first time the major geological features of Albemarle County.

FIELD WORK AND ACKNOWLEDGMENTS

The geological mapping of Albemarle County was started by the author in 1925. From that date to the present, part of each year, except in the years 1941 to 1945, were spent mapping the geology of this area. The work has now been completed and the geological map accompanying this report has been compiled from field work during the past thirty-five years, assisted by members of the class in structural geology at the University of Virginia throughout part of this period.

Numerous Master's theses have been prepared under the author's direction at the University of Virginia, some of which covered in part Albemarle County. Of these the thesis of Robert Clay Vernon, on the "Geology of the Crozet and Pasture Fence Mountain Area, Albemarle County, Virginia," should be mentioned. This work has been modified by the author and a different structural interpretation made of the area.

The Mechum River slate belt was mapped and described by E. O. Gooch as his Ph.D. Thesis at the University of North Carolina. As this map was made on a highway map base it is impossible to use these boundaries on the map of the county. Boundaries of the Mechum River formation and the structural interpretation placed on this belt are by the author.

The aid and courtesies extended over the past years by the many residents of the county are highly appreciated.

The officials and employees of the Alberene Soapstone Division of the Georgia Marble Company, and its forerunner, have extended many courtesies to the author.

During the past years many eminent geologists have visited this area and have been of assistance to the author. They were George W. Stose and Mrs. George W. Stose (formerly Anna I. Jonas), Charles Butts, R. S. Bassler, E. O. Ulrich, David White, Arthur Keith, geodesist Col. William Bowie and geophysicist Maurice Ewing.

Dr. Robert S. Young has furnished geophysical data of the magnetic iron ore mine on Cook Mountain, near North Garden, and of the Ohio Sulphur Mining Company's abandoned property at Proffit, which are included in this report.

Ground water well data, used in the chapter on ground water was obtained from Cross (1960) and from information furnished by the Division of Mineral Resources from its files.

The preparation and publishing of the Albemarle County geological report, with accompanying geologic map, have been made possible by James L. Calver, Commissioner of Mineral Resources and State Geologist of Virginia.

GEOLOGICAL FORMATIONS

INTRODUCTION

Before the geological formations of Albemarle County can be discussed it is essential that the Precambrian, Cambrian and younger rocks occurring in this area be properly correlated. Considerable work has been done by a number of geologists in two Piedmont localities, Charlottesville and Lynchburg, (Brown, 1958) but no correlation of the sections made at these two places has heretofore been attempted.

The best geological section found in the Piedmont of Virginia, where rocks from the Lovington basement complex up to the Loudoun formation of Cambrian age occur, with a minimum of faulting and metamorphism, is from Waynesboro, at the western foot of the Blue Ridge, eastward twenty-five miles through Afton, Ivy, Charlottesville and to Shadwell at the eastern foot of Southwestern Mountain. This section is along Route 250 from Waynesboro to Shadwell.

PRECAMBRIAN SYSTEM

LOVINGSTON GNEISS FORMATION

The Lovington quartz monzonite, commonly referred to as Lovington gneiss, forms the basement complex of Precambrian age in Albemarle County. This formation is exposed in a wide belt extending northeast and southwest, bounding the Mechum River formation on the east and extending to the western edge of a northeast-southwest line drawn through the western edge of Charlottesville. South of the Miller School this formation extends west of the Mechum River graben to the Nelson County line. This formation is quite variable in composition but is generally a coarse grained granular rock. As a rule the rock weathers deeply. It was considered to be a paragneiss by Mertie (1956).

This rock contains as its major minerals plagioclase and orthoclase feldspars, and as minor minerals quartz with biotite mica and hornblende. The accessory minerals are apatite, zircon and opaque oxides.

Numerous small elliptical areas of igneous rock, from one to three miles in length, have been injected into the Lovington gneiss. North of Charlottesville a white granite gneiss occupies a large elliptical area on the east edge of the Lovington, replacing part of the Lovington and all of the Rockfish conglomerate formation. It extends from the County High School on State Route 743 northeastward to Piney Mountain and underlies the Albemarle County-Charlottesville airport. The best exposures are in

GEOLOGIC FORMATIONS OF ALBEMARLE COUNTY

TABLE 1

AGE	FORMATION NAME	MAP SYM- BOL	CHARACTER	THICK- NESS IN FEET
Triassic	Newark, three facies	T	First an eastern facies, poorly sorted red, sandy, silt-like material grading upward into second facies, a fan-glomerate composed of large rounded fragments of Cactoin, granite and quartz followed by a third facies, red, gray and green, silty sandstone and occasionally quartz pebble conglomerates.	Approx. 9000
		d	Diabase dikes: essentially composed of labradorite and pyroxene and characterized by ophitic texture; maximum thickness 300 feet.	
		gb	Gabbro dikes: medium grained, highly epidotized, chloritized green gabbro; maximum thickness 100 feet.	
		f	Felsite dikes: cryptocrystalline aggregate of quartz and potassium feldspar; maximum thickness 66 feet.	
Ordovician		a	Alaskite dikes: essentially composed of orthoclase and microcline with subordinate quartz. Few or no basic constituents.	20
		am	Amphibolite dikes: crystalloblastic rocks consisting mostly of amphibole and plagioclase.	Max. 2100
Cambrian	Everona limestone	Cev	A thin to thick bedded blue-black limestone sandy limestone and, in places, siliceous white marble.	50- 1000
	Erwin quartzite (Antiedam)	Cer	Massive layers of depositional quartzite separated by layers of fine grained, shaly sandstones.	

TABLE 1—CONTINUED

Cambrian or Pre- cambrian	Loudoun formation (Unicoi-Weverton)	EpCl	Upper part sandstones, shaly sandstones and pink paper bedded shales, then micaceous sandstone and glassy ferruginous sandstone then, at base, three greenstone lava flows separated by coarse arkosic quartzitic sandstone with a 10 foot conglomerate at base and a 175 foot acid lava flow at top.	3220- 7000
	Catoclin formation with alaskite dikes	EpCc	Originally a series of basaltic lava flows separated by layers of sediments, now a greenstone with patches of epidote.	5000- 28500
		g	Greenstone feeder dike	
		s	Sandstone lens	
	Swift Run formation with amphibolite and metaproxenite dikes	EpCs	A series of detrital quartzite and tuffaceous slates and greenstone flows at its type location	100- 2200
	Mechum River formation	EpCm	Composed of Swift Run formation and thinned down western edge of Charlottesville, Lynchburg and Rockfish formations mapped as a unit.	Occupies a belt from $\frac{1}{2}$ to $1\frac{1}{2}$ miles wide

TABLE 1—CONTINUED

AGE	FORMATION NAME	MAP SYM- BOL	CHARACTER	THICK- NESS IN FEET
Precam- brian	Virginia Blue Ridge complex	pCv	Includes granodiorite, hypersthene granodiorite and the Marshall and Crozet granites.	
	Charlottesville formation with 6 or more metapyroxenite dikes	pCch	Primarily massive layers of quartz biotite gneiss, calcareous in places; also a few beds of sericitic and graphitic schist.	4300- 12600
	Johnson Mill formation	pCjm	Massive graphite slate containing pyrite stringers and blobs.	250- 400
	Lynchburg formation (Restricted)	pClyg	Fine grained silty sediments, metamorphosed in part, varved-like layers of graphitic and sericitic schist and thick beds of quartz biotite gneiss.	4500- 12000
	Rockfish conglomerate	pCr	Basal 100 foot boulder conglomerate followed by coarse metamorphosed sandstone.	1200- 6000
	Lovington formation with injections of igneous rock	pClgr	Coarse grained quartz monzonite, variable in composition.	

the highway cuts around the airport. The granite gneiss at this location, according to Mr. Baetcke, is composed of 59.4% feldspar, 33.1% quartz, 4.4% biotite and 3.0% epidote. This thin section is very similar to the Marshall gneiss described by Brown, Virginia Division Mineral Resources, Bulletin 74, Plate 11B.

On Route 29, near Crossroads, eleven miles south of Charlottesville, there is an elliptical area of pegmatite granite, or syenite, about one mile in length. It was described by Edmundson (1930) as follows: "It is a coarse granite pegmatite, white to light gray in color with porphyritic texture. The major minerals are feldspar and quartz; white epidote and mica occur in minor amounts. It is well exposed near Trinity Church on State Highway 692."

Three other elliptical areas occur near the southwest edge of the county near Faber, on Route 6, and South Garden on Route 712. One area is exposed on the headwaters of Bear Creek and the other two on State Highway 633. The area near Faber is described by Cook (1952), and is called Applebury granite as it occurs on the west side of this mountain. It is a light gray, coarse grained granite. Mr. G. B. Baetcke, of the Virginia Mineral Resources Division, reports that this granite gneiss is composed of 84.2 percent feldspar, 11.5 percent quartz, 1.8 percent chlorite and 2.4 percent epidote. This granite gneiss is intrusive into the Lovingson gneiss and the Rockfish conglomerate.

A metamorphosed quartz diorite area, two miles in length, occurs south of Covesville near the Nelson County line. It is well exposed in a small abandoned quarry on the east side of Highway 29, about two hundred yards south of its junction with State Highway 632. According to Mr. G. B. Baetcke this metamorphosed quartz diorite is composed of 61.4 percent feldspar, 29.7 percent quartz, 6.3 percent biotite and 2.4 percent epidote. The feldspar is generally altered to sericite and the quartz and feldspar are fractured.

Excellent exposures of the Lovingson occur on Highway 29, south of Charlottesville to the Nelson County line, also on Highway 250 from the intersection of the Highway 250 bypass around Charlottesville west to Mechum River, and at Isreal Gap on State Highway 692. An exceptional exposure is in the large quarry at Red Hill on the south end of Dudley Mountain (Figure 18).

VIRGINIA BLUE RIDGE COMPLEX

The Virginia Blue Ridge complex in this area includes granodiorite, hypersthene granodiorite and the Marshall and Crozet granites, and is

equivalent to part of the Pedlar formation. It extends from Floyd County to Front Royal, a distance of 150 miles.

The texture of the Virginia Blue Ridge complex is from medium to coarsely granular. It has a green to gray color, and generally has a greasy or waxy appearance. It has been classified as a plutonic rock consisting of quartz, oligoclase or andesine, and orthoclase feldspar with biotite mica, hornblende or pyroxene (hypersthene) as basic constituents. Mertie (1956) classified the granodiorite as a sedimentary gneiss and called it a paragneiss. In certain belts it is porphyritic in texture, with phenocrysts of orthoclase feldspar which, in a belt just west of the Mechum River graben, have been altered by intense sheering into a beautiful augen gneiss. Such an augen gneiss is well exposed on State Highway 671, one-half mile north of the bridge over Moormans River at Millington.

The Virginia Blue Ridge complex is younger than the Lovingson gneiss. An age determination by Jaffe is 560 million years.

The Virginia Blue Ridge complex is well exposed in the northern part of the County on State Highway 810, just west of Nortonville, and on the Spottswood Gap Highway across the Blue Ridge just north of Albemarle County.

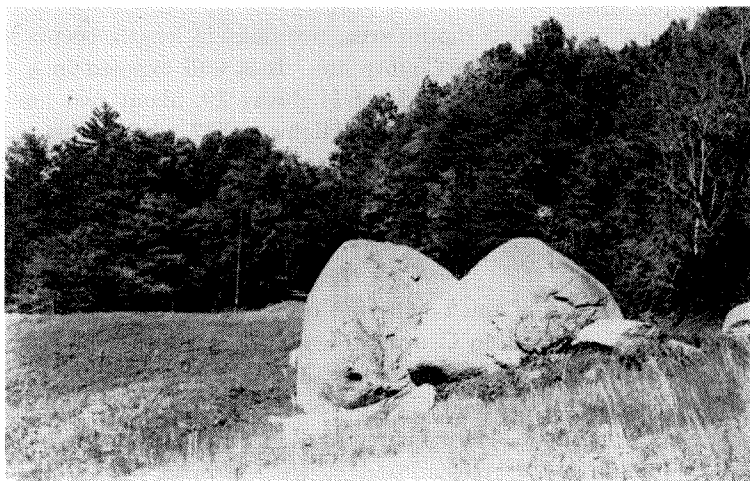


FIGURE 3. A split spheroidally weathered boulder of Virginia Blue Ridge complex at dam of Charlottesville's reservoir on Moormans River, approximately 4.5 miles west of White Hall.

The Crozet porphyritic granite occurs around Crozet, and at the dam of the City of Charlottesville in the gorge of Moormans River between Bucks Elbow Mountain and Pasture Fence Mountain (Figure 3). At this latter place Mr. Baetcke reports that it is composed of 83.8% feldspar, 14.0% quartz and 2% epidote. The feldspars are fractured and contain veinlets of chlorite and epidote.

The Marshall granite is best exposed at Marshall, Virginia, north of Albemarle County.

Unakite is an epidotic rock containing pink feldspar. It has been used in making semi-precious jewelry. It was named by Bradley (1874). It occurs in this county at or near the contact of the Virginia Blue Ridge complex, where granodiorite is close to Catoctin greenstone. Unakite has been found in Sugar Hollow and on the North Fork of Moormans River.

ROCKFISH CONGLOMERATE FORMATION

The Rockfish conglomerate lies unconformably upon the Lovingson gneiss (Nelson 1932). It is approximately 1200 feet thick at its type locality just west of Rockfish Station on the Southern Railway (Figure 4).

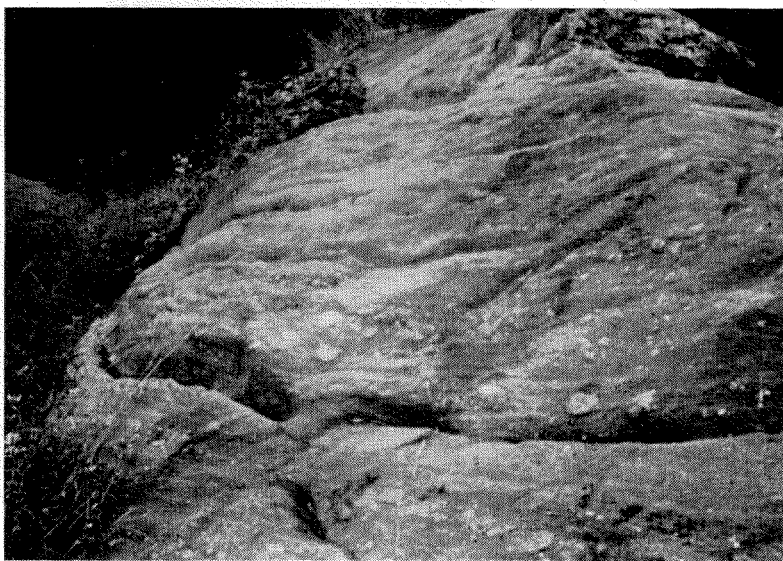


FIGURE 4. Rockfish conglomerate at type locality (Nelson County) 800 feet above unconformity between Rockfish conglomerate and Lovingson gneiss.

At this point the rocks are slightly overturned and dip about 80° to the west, with the Lovington gneiss lying overturned on the Rockfish conglomerate.



FIGURE 5. Basal 100 feet of Rockfish conglomerate at type locality, Nelson County.

The basal 100 feet of the Rockfish conglomerate (Figure 5) is composed of rounded and sub-angular pebbles and boulders up to 12 inches in diameter, composed of the Lovington quartz monzonite. These boulders and smaller pebbles occur in nests separated by several feet. The matrix between these boulders looks exactly like the Lovington gneiss and could not be distinguished from the Lovington gneiss visually unless pebbles or boulders were present. It also was described by Cooke (1952).

The Rockfish conglomerate occurs in a belt on the southeast side of the Lovington gneiss from a point on the Nelson County line 1.3 miles northeast of Faber to the northwestern edge of Charlottesville (Figure 6).



FIGURE 6. Rockfish conglomerate on State Road 774 about 1.5 miles northeast of Faber.

The lower hundred foot boulder bed is, in many places, faulted out by the border fault of the Lovington gneiss where it occurs at the contact between the Lovington gneiss and the Rockfish conglomerate.

At Charlottesville, on Route 29, only about 50 feet of the boulder bed is exposed on the east side of this border fault, at the entrance to Buckingham Circle, but above it the upper part of the Rockfish conglomerate is a coarse, metamorphosed sandstone with a thickness of 3,200 feet, all well exposed on Highway 29 from Buckingham Circle to Piedmont Avenue in Charlottesville. On the Barracks Road, on the northwest side of Stillhouse Mountain, quartz pebbles up to 2 inches in diameter form a ledge mentioned by Rogers (1894) and Lambeth (1901).

LYNCHBURG GNEISS FORMATION (RESTRICTED)

There is no distinct boundary line between the Lynchburg gneiss and the Rockfish conglomerate. The coarse sedimentation of the Rockfish conglomerate changes quickly within a few inches to fine, silty sediments of the Lynchburg gneiss containing graphitic and sericitic, or feldspathic

varved-like layers and thick beds of quartz biotite gneiss. The quartz biotite gneiss weathers to a silty tan soil.

The Lynchburg gneiss was named from its outcrops in Lynchburg, Virginia, by Jonas (1927), who described it as a partly garnetiferous, fine to medium grained, banded biotite-quartz gneiss and schist. It is less metamorphosed in Albemarle County than at its type locality.

In Albemarle County the Lynchburg gneiss occurs in a distinct northeast-southwest belt to the east of the Rockfish conglomerate south of Charlottesville. From Charlottesville north to Piney Mountain and the county line the Lynchburg gneiss is bordered on the west by an acid granite which has been injected into the Lovington gneiss at its eastern border.

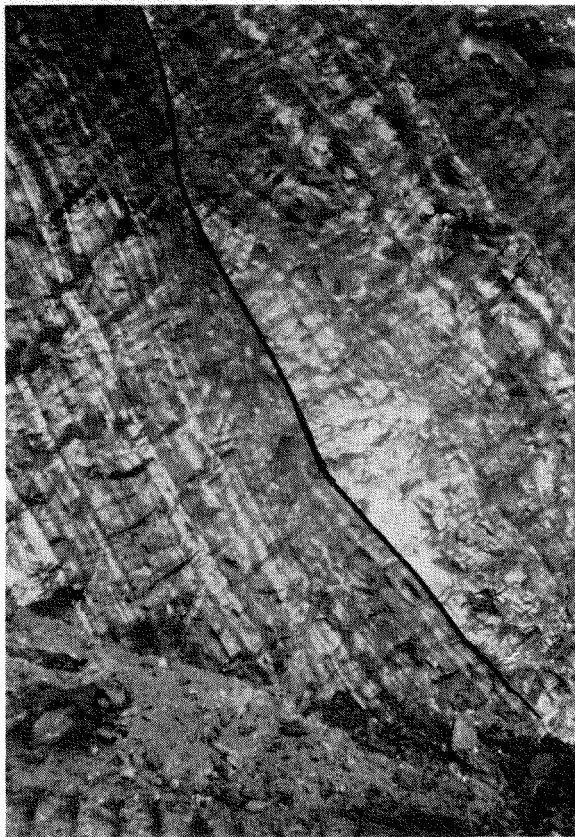


FIGURE 7. Banded Lynchburg gneiss at north end of Barracks Road Shopping Center, Charlottesville. Minor faults are also evident.

North of Charlottesville the width of the Lynchburg belt increases greatly, which is due, in part, to folding and faulting and probably, in part, to an increase in thickness of the sediments making this formation (Figure 7).

In this report the term "Lynchburg gneiss" is used for the rocks lying above the Rockfish conglomerate and below a 300 foot bed of black graphitic slate, which is well developed in Albemarle County.

JOHNSON MILL GRAPHITE SLATE FORMATION

The Johnson Mill graphite slate formation, which is the name used for these rocks in lectures in structural geology at the University of Virginia since 1945, has its type locality at Johnson Mill (Highway 712) on the Hardware River, 2.7 miles southeast of North Garden on the Southern Railway in south-central Albemarle County.

At this locality the slates have a dip of 65° to the southeast and have a true thickness of around 300 feet. They are underlain on the west by approximately 50 feet of varved-like graphitic and sericitic schist next to a major fault which has faulted out the rest of the Lynchburg.

The slate belt is bordered on the southeast by massive beds of quartz biotite gneiss. The slate contains numerous stringers and blebs of pyrite scattered throughout its entire thickness, making it a typical faldband ore deposit.

At Proffit, in 1918, a shaft mine was opened by the Ohio Sulphur Mining Company, in the slate belt, hoping to develop a pyrite mine. This formation was laid down on the base-leveled truncated beds of the Lynchburg formation. As this formation has approximately the same thickness throughout the entire length of Albemarle County and its outcrop shows on the geologic map of the county as almost a straight line, except where it is offset by faulting, it was not involved in the folding to which the underlying Lynchburg gneiss was subjected.

Gravatt (1920) prepared a map of part of this graphite belt, which was published by the Virginia Geological Survey. It locates two shafts and several prospect pits.

In addition to the Proffit mine, a shaft is shown on Mill Creek slightly over one-half mile northwest of Gilbert Station on the Southern Railway.

This geological map lists the graphite schist and the quartz mica schists mapped on either side of it as Cambrian in age. It also states that the graphite schist is phosphatic in places, but does not give the locations.

CHARLOTTESVILLE FORMATION

The Charlottesville formation, which formational name has been used in structural geology lectures at the University of Virginia since 1945, is probably the upper part of the Lynchburg formation at Lynchburg. It has a thickness of approximately 4,500 feet at its type locality in Charlottesville. It lies above the Johnson Mill graphite slate formation and is composed primarily of massive layers of quartz biotite gneiss, calcareous in places, with a few beds of sericitic and graphitic schist. All of the sediments making up this formation are exceedingly fine grained. It occurs in a belt extending in a northeast direction from Charlottesville to the county line, and in a belt extending in a southwest direction from Charlottesville to the Nelson County line in the vicinity of Schuyler.

There are numerous soapstone dikes occurring in this formation, best developed along the Nelson County line. The dikes extend northeastward, in workable thickness, to Alberene, and still further northeastward into Charlottesville, where the two dikes which occur are not suitable or thick enough for quarrying.

Unweathered outcrops of this formation occur on Rose Hill Drive in Charlottesville, where it crosses a tributary of Shenks Branch. It also occurs on Highway 600 east of Watts Station on the Southern Railway.

CAMBRIAN OR PRECAMBRIAN SYSTEM

SWIFT RUN FORMATION

The Swift Run formation was named by Stose and Stose (1946) from its type locality on U. S. Highway 33, just east of Swift Run Gap, and on the Skyline Drive just north of the gap.

This metamorphosed, sedimentary and volcanic formation is composed, at its type locality, of a series of detrital quartzite and tuffaceous slates, which lie directly on the Virginia Blue Ridge complex. At this point it has a thickness of 100 feet or more, and at its base is a thin greenstone lava flow.

This type locality is in the county adjacent to Albemarle County on the north.

The thickness of the Swift Run formation in the Blue Ridge in Virginia varies from less than one foot near Stony Man Mountain on the Skyline Drive, where the Catoctin rests directly on the Swift Run to 1,380 feet in Sugar Hollow (Vernon, 1952), just east of Jarman's Gap in Albemarle

County along State Highway 614. The section is as follows: (Vernon, 1952)

SECTION OF SWIFT RUN FORMATION IN SUGAR HOLLOW		<i>Feet</i>
Arkosic quartzite		600
Quartz sericite schist		180
Metamorphosed tuffs, etc.		250
Metamorphosed basalt		100
Arkosic quartzite and conglomerate		250
Contains 50 foot bed of white quartzite		
		<hr/> 1,380

This formation is infolded and probably faulted into the domed Virginia Blue Ridge complex in several elliptical narrow bands which surround the remarkable Fox Mountain dome.

In addition there are several elliptical synclinal areas just west of the Mechum River belt of metamorphosed rocks extending from just south of Crozet to the Greene County line.

The upper part of the metamorphosed rocks in the Mechum River formation are part of the Swift Run formation.

In the central part of the county the Swift Run formation occurs at the western edge of Southwestern Mountain, in a belt extending northeast and southwest, lying at the base of the Catoctin greenstone. It occurs above the Charlottesville formation in this belt. This is the eastern belt of the Swift Run formation of Stose and Stose (1946). This formation has increased greatly in thickness in its extent eastward from its most western outcrop along the crest and foot of the Blue Ridge Mountains.

In Charlottesville the base of the formation is composed of 300 feet of quartzitic sandstone, containing large blue quartz pebbles. The fine silt-like type of sediments of the Charlottesville formation changes quickly where the Swift Run formation starts.

Above the 300 feet of massive quartzitic conglomerate, containing pebbles up to $\frac{1}{2}$ inch in diameter which occur at the base of the Swift Run, is a 60 foot amphibolite dike. Above it are 600 feet more of predominately coarse quartzitic sandstones with much blue quartz. Above these massive beds there occurs about 1100 feet of coarse and medium grained metamorphosed sediments. In the top part of this formation there are two greenstone lava flows 40 to 50 feet thick, separated by a 2 foot layer of altered volcanic ash. At the top of the formation there are several layers of sericitic schist containing perfect magnetite crystals about 1 millimeter in diameter and a 5 foot metapyroxenite dike.

The total thickness of the Swift Run formation in Charlottesville is 2,250 feet, while on the Nelson County line it has thinned down to 1,300 feet. North of Charlottesville it is 2,600 feet thick on Redbud Creek west of Eastham, while at the Orange County line it has a thickness of 2,200 feet.

The section given above was measured on Hartman's Mill Road and Ridge Street in Charlottesville.

MECHUM RIVER FORMATION

The Mechum River formation occupies a graben belt from $\frac{1}{2}$ mile to $1\frac{1}{2}$ miles wide. It is composed of the Swift Run formation at its top, with the thinned down western edge of the Charlottesville, Lynchburg and Rockfish formations below the Swift Run in that order. Most of this infold is probably composed of the Swift Run formation with little or no Charlottesville and Lynchburg rocks, but with well developed Rockfish conglomerate, in places lying next to the fault on its eastern edge, and at the southern end of the graben on Sharp Top Mountain (Gooch, 1954).

The rocks are intensely metamorphosed and are given this inclusive name as no attempt was made to separate this formation into its components. It is mapped as a unit.

CATOCTIN FORMATION

In 1841 Rogers (1884) considered the Catoctin greenstone to be of igneous origin, although originally, in 1835, he referred to it as a metamorphosed greenish and dark blue argillaceous sandstone.

In 1894, the true igneous origin of the greenstone was determined by Arthur Keith (1894) in the Harpers Ferry Geologic Folio. He called it "Catoctin schist" (1891).

In 1928 a geologic map of Virginia was published under the direction of the author. Geo. W. Stose was editor of the map and the name "Catoctin greenstone" was used, which name has been in use since that date.

In Albemarle County the Catoctin greenstone occurs in two belts, extending in a northeast and southwest direction. The northwestern belt follows the crest of the Blue Ridge. The southeastern belt makes up Southwestern Mountain (Figure 17). The southern extension of Southwestern Mountain is known as Carter Mountain and Green Mountain. These two belts of greenstone occur on the northwestern and southeastern edges of the Southwestern Mountain-Blue Ridge anticlinorium. It is generally a massive rock, containing ledges or patches composed mostly of epidote. Many layers are vesicular, containing original gas bubbles, or

cavities, which have been flattened or filled with quartz, epidote and jasper. Remains of original columnar jointing occur along the Chesapeake and Ohio Railway in the gorge of the Rivanna River, and at places on the Skyline Drive and the Blue Ridge Parkway. It was originally a series of basaltic lava flows separated by layers of sediments. In places the greenstone is sheared and schistose and is almost a chlorite schist.

The Catoctin greenstone is composed of numerous altered lava flows separated from each other by beds of metamorphosed sediments, which, in most cases, are likewise altered to greenstone. Where greenstone containing angular or rounded pebbles occurs such layers are metasediments. Several such layers occur on the Chesapeake and Ohio Railway in the gorge of the Rivanna River.

The present color of this formation is due to the minerals chlorite and epidote. The epidote ledges are massive and yellowish green, while the chlorite layers are dark or gray green and sometimes schistose.

The Catoctin greenstone occurring on the crest of the Blue Ridge and down its eastern slope, and on Bucks Elbow Mountain and Pasture Fence Mountain just east of the crest of the Blue Ridge, is well exposed in many places both in Albemarle County and just outside of Albemarle County in Nelson, Augusta and Greene counties, and northward into Maryland.

The best exposure of the entire Catoctin greenstone is on U. S. Highway 250 from the Tuckahoe Motor Court in Albemarle County to 100 yards west of the Blue Ridge Parkway overpass in Rockfish Gap in Nelson County. This formation is 6,800 feet thick in this area. It is overturned. Its lower contact with the Swift Run formation is 200 feet west of the Tuckahoe Motor Court, while its upper contact with the Unicoi (Loudoun) formation is 100 yards west of the Blue Ridge Parkway overpass. The entire formation is overturned along Route 250 across the Blue Ridge Mountains.

The Skyline Drive in the Shenandoah National Park has excellent exposures of greenstone from Scott Mountain north to Calf Mountain, a one-fourth of a mile exposure at Jarmans Gap, and $2\frac{1}{4}$ miles north of Browns Gap just over the county line where the greenstone contains an altered lava flow full of $\frac{1}{4}$ inch to 1 inch feldspar phenocrysts. On the Blue Ridge Parkway, 1.8 miles south of Rockfish Gap, a fine exposure of basaltic, columnar jointing occurs on the west side of the highway (Figure 8).

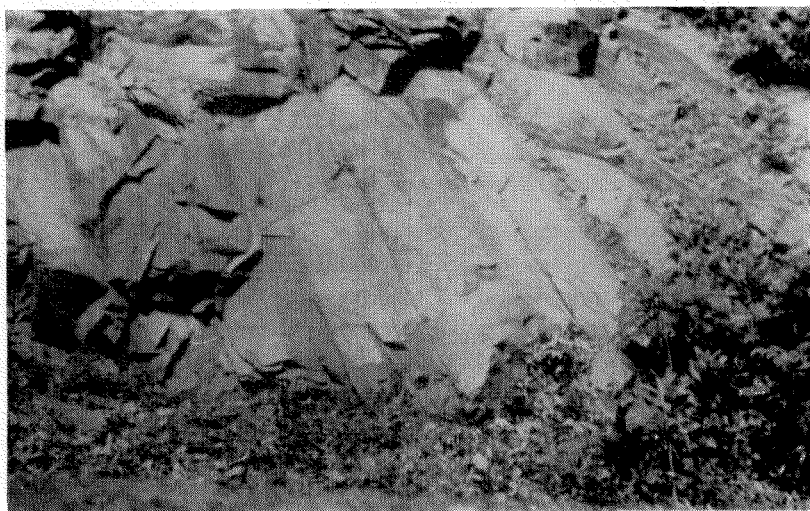


FIGURE 8. Columnar jointing in Catoctin formation on Blue Ridge Parkway, 1.8 miles south of Rockfish Gap.

The Catoctin greenstone is 23,000 feet thick in Southwestern Mountain just west of Keswick, to 15,000 feet thick at Monticello, and 31,000 feet thick on the Orange County line. At Carter Bridge it is 7,000 feet thick and on the Nelson County line it is 5,000 feet thick.

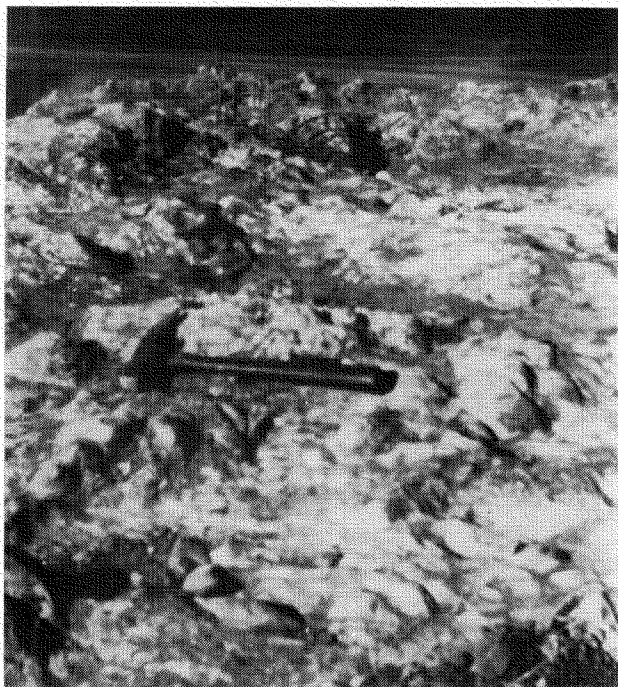
The Catoctin weathers very deeply in the Southwestern Mountain belt and there are few good exposures. The best exposure across the entire belt is along the Chesapeake and Ohio Railway from Charlottesville to Shadwell, where it follows the Rivanna River as it cuts through Southwestern Mountain. Columnar jointing occurs at one place, and layers of greenstone with rounded pebbles occur at several places.

From the Keswick Country Club southwestward to Overton massive quartzitic sandstone, with pebbles, separates the two upper greenstone flows. This quartzitic sandstone is well exposed on the road extending from Highway 795 into Ash Lawn.

Near the base of the Catoctin greenstone, one-half mile north of Eastham, on Highway 20, a 10 foot conglomerate separates two of the lava flows. This conglomerate can be traced for one-fourth mile and crosses Highway 20 about one-half mile north of Eastham.

A conglomerate, with greenstone pebbles ranging in size from 1 inch to 5 feet in diameter but most commonly from 6 to 8 inches along the

longest diameter, occurs from just north of the Hardware River to the Orange County line along the east foot of Southwestern Mountain, often adjacent to or paralleling Highways 22 and 23, and becoming thicker to the north (Figure 9). The best contrasting sizes occur on the Castalia estate near Cismont.



By Cordova

FIGURE 9. Greenstone conglomerate near top of Catoctin formation near Keswick.

The conglomerate is about 300 feet thick at the Charlottesville Stone Quarry. North of Shadwell it has a thickness of 1,300 feet, while just north of the county line its thickness has decreased to 900 feet (Cordova, 1955).

There are two isolated occurrences of greenstone on the western edge of the Scottsville Triassic Basin. One occurrence is bisected by the Chesapeake and Ohio Railway one mile south of Dawson Mill, the other is roughly bisected by Highway 736 between Mt. Alto Church and McCullough.

LOUDOUN (UNICOI) FORMATION

The Loudoun (Unicoi) formation occurs in two belts in Albemarle County. The northwestern belt occurs along the crest of the Blue Ridge just west of the major high angle thrust fault which roughly parallels the crest of the Blue Ridge along the northwestern part of Albemarle County. The eastern belt occurs east of Southwestern Mountain and covers most of the eastern third of Albemarle County.

The Loudoun formation was named by William B. Clark (1893) from its type locality in Loudoun County, Virginia. It is the equivalent of the Unicoi formation which occurs on the crest of the Blue Ridge in Albemarle County and was named by Campbell (1899) from Unicoi County, Tennessee. This formation has also been referred to as the Weverton sandstone, from its type locality at Weverton, Maryland, one mile east of Harpers Ferry (Keith, 1894).

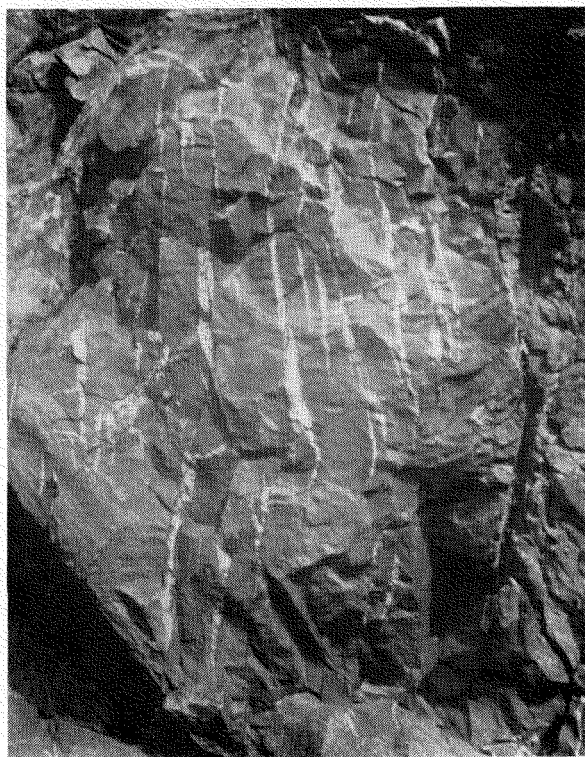


FIGURE 10. Gash veins in epidotized quartzitic sandstone in the base of the Unicoi formation on U. S. Highway 250 just west of Rockfish Gap.

In the Blue Ridge belt this formation is divided into an upper, middle and lower section, and is known as the Unicoi formation. An almost continuous exposure of the Unicoi formation occurs along U. S. Highway 250, starting about 100 yards west of Rockfish Gap to the Chesapeake and Ohio Railway overpass (Figure 10), then along the Chesapeake & Ohio Railway to the city limits of Waynesboro.

The complete section is as follows:

LOUDOUN FORMATION (UNICOI)

	<i>Thickness in Feet</i>
Sandstones and shaly sandstones and sandy shales and sericitic shale beds repeated many times overlying yellow and pink paper bedded shales (225 feet).	Upper part 1,050
Coarse and fine grained micaceous sandstones, and shaly sandstones, and glassy ferruginous sandstones and several beds of siliceous hematite.	Middle part 1,425
Three Catoctin type lava flows separated by coarse arkosic quartzitic sandstones, with a 10 foot conglomerate at base, and a 175 foot acid lava flow at top.	Lower part with acid flow at top 745
This lower part is mapped as Catoctin by Reed around Big Meadows and Skyland, as the acid lava flow is mapped as the top of the Catoctin greenstone.	
	Total 3,220

The Loudoun (Unicoi) formation forms the crest of the Blue Ridge, and part of the upper eastern slope, in Albemarle County from Jarmans Gap, 6¼ miles northeast of Rockfish Gap, to the county line, except for a distance of about one mile just one mile south of the Greene County line, in the Eppert Hollow area, where the crest of the Blue Ridge is composed of Catoctin greenstone. The Skyline Drive in the Shenandoah National Park, from Jarmans Gap northward to Browns Gap and on to the Greene County line, has many parking overlooks at which excellent exposures of unweathered Unicoi rocks occur.

The contact between the Loudoun and the Catoctin formations, on the east side of Southwestern Mountain, shows that the middle and lower part of the Loudoun formation is missing. Lying on top of the Catoctin are the yellow and pink paper bedded shales, which occur at the base of the upper part of the Loudoun in the Waynesboro section, showing that the Loudoun formation was laid down on the bottom of an advancing sea from west to east, or that an excessive thickness of Catoctin greenstone did not subside until upper Loudoun time. King (1954) also found evidence of the overlap of the Loudoun formation on the Catoctin.

The middle and lower part of the Loudoun were not deposited in the eastern part of Albemarle County.

The Loudoun extends from Shadwell along U. S. Route 250 eastward almost to Limestone Creek, a distance of 2.5 miles. It is well exposed from Shadwell to Limestone Creek. It also occurs in a belt on the far side of Limestone Creek to the county line. It is composed at its base of sandy schist-like material overlain by yellow, pink and red thin-bedded to paper-bedded shales. These paper-bedded shales occur over 2,170 feet above the base of the Loudoun in the western belt on the west side of the Blue Ridge Mountains.

Excellent exposures of the Loudoun occur on U. S. Route 53 from Simeon to Buck Island Creek.

The Loudoun formation makes a broad belt, from 7,500 feet to 16,500 feet wide, extending in a northeast-southwest direction across the county, just southeast of Southwestern Mountain, Carter Mountain and Green Mountain.

The upper part of the Loudoun, which is 1,050 feet thick on the western edge of the county, has increased to 7,500 feet in thickness between Keswick and Rugby Station on the Chesapeake and Ohio Railway. This is the only part of the Loudoun which was deposited in the eastern part of Albemarle County.

The Loudoun slates were quarried at Esmont in Albemarle County and are referred to as the Candler Formation (Espenshade, 1954). They have also been quarried in the past between Overton and Blenheim.

CAMBRIAN SYSTEM

HARPERS SHALE (HAMPTON SHALE)

Harpers shale was named by Keith (1893) from its type locality at Harpers Ferry, Maryland. Hampton shale was named by Campbell (1899) from its type locality at Hampton, Carter County, Tennessee.

This formation, which occurs between the Unicoi and Erwin formations, has been removed by erosion along the crest of the Blue Ridge at Black Rock Mountain. It was either not deposited, or eroded, above the top of the Loudoun in the vicinity of Limestone Creek in eastern Albemarle County.

ERWIN QUARTZITE FORMATION (ANTIETAM SANDSTONE)

The Erwin quartzite was named by Keith (1903) from Erwin, Unicoi County, Tennessee. The Antietam sandstone was named by Keith (1893)

from Antietam Creek, Maryland. It is composed of massive layers of depositional quartzite separated by thinner layers of fine grained silty sandstone.

This formation occurs in Albemarle County at Black Rock Mountain, on the crest of the Blue Ridge near the northwest corner of the county, and south along the Skyline Drive for three miles. The top of the mountain is the Erwin quartzite, which has a black-like color due to the quartzite being covered by lichen.

The upper part of the formation has been eroded so no detailed section is given. The entire formation is several hundred feet thick. It is well exposed in an abandoned quarry on the east edge of Waynesboro and can be seen from Highway 250.

EVERONA LIMESTONE FORMATION

The Everona limestone formation was named from its type locality, Everona Post Office, now abandoned, Louisa County, Virginia, by Jonas (1927). At this location a limestone bluff gives a good exposure of part of the formation.

This formation is composed of thin to thick bedded, blue-black limestone, sandy limestone, and, in places, a white siliceous marble.



FIGURE 11. Nearly flat-lying beds of Everona limestone in Everona syncline exposed in Garland Quarry on State Highway 53 near Buck Island Creek.

The Everona limestone occupies the axis of the first synclinal trough to the east of Southwestern Mountain and Carter Mountain. This limestone belt, which extends in a northeastern-southwestern direction across Albemarle County, is well developed from the point where it crosses the Rivanna River northeastward to the Orange-Albemarle County line (Figure 11). Southwest of the crossing of the Rivanna River the boundaries of this formation are obscured and only a few limestone outcrops occur in isolated areas. This formation could become lense-like in character southwest of the Rivanna River or could, in places, be a siliceous limestone or a limy sandstone.

The boundaries of the formation south of the Rivanna River are so obscure that they are shown on the map by dotted lines.

When the map of Virginia was published (Nelson, 1928) the Everona limestone was listed by Jonas and Stose as Ordovician in age because of its resemblance to, and its position along the strike of the Frederick limestone of Maryland. At that time Bassler was of the opinion that the Frederick limestone was of Ordovician age. In 1936 a paper on the age reclassification of the Frederick Valley limestones was published by Jonas and Stose (1936). In this paper the Frederick limestone was classified as of Upper Cambrian age, so, if the Everona limestone is the equivalent of the Frederick limestone, it should be classified as Upper Cambrian age. It is so classified in this report.

TRIASSIC SYSTEM

TRIASSIC ROCKS

All of the Triassic formations in Virginia are of continental origin and belong to the Newark formation (Redfield, 1856). They were deposited in basins.

Triassic rocks in Albemarle County were mentioned by Rogers (1836), Fontaine (1883), Darton (1891), Heinrich (1878), Hotchkiss (1885), Roberts (1928), Kingery (1954), McKee and others (1959).

One of the first detailed descriptions, with map, was by Heinrich (1879), who referred to the Barboursville deposits as a small area in Orange County nine miles long by two miles wide. He did not realize that this area extended a fraction of a mile into Albemarle County. The James River deposits were described as "showing exposures west of Scottsville below the mount of the Rockfish River, upon the north side of it. Its area cannot yet be computed correctly." Plate V of this report shows

both the Barboursville area and the Scottsville area, the latter extending northward to the Flandevare River, now known as the Hardware River.

Triassic rocks occur in the northern edge of Albemarle County, along the county line just south of Barboursville. This is the southern edge of the Culpeper Basin which extends a short distance into Albemarle County and is bordered by normal faults. A new, small, isolated Triassic area was located by the author two miles west of the main basin on Highway 641. The rocks are a red, sandstone conglomerate. It outcrops in a triangular area, several hundred feet long, on the northwest fork of Priddy Creek. The boundaries are shown on the geologic map of Albemarle County.

A large Triassic area occurs in the southern part of the County from Scottsville northward almost to Keene, and extends in a southwestern direction to the county line on Rockfish River. The Triassic rocks in this area are bounded by a series of faults on the north and northwest side, and on most of the southwest side. The boundaries of this Triassic area have been remapped in detail by the author and differ somewhat from the previous map boundaries.

The Triassic rocks in the Scottsville Basin have been divided into three facies, following the plan used by Kingery (1954):

First: An eastern facies composed of poorly sorted red, sandy, silt-like material, grading upward into the second facies.

Second: A fanglomerate, a massive boulder bed composed of large, rounded fragments of Catoclin greenstone, Precambrian granites and vein quartz, which is in places cemented by an intrusive gabbro. This fanglomerate is well exposed on State Highway 20 at Glendower.

A gabbro dike occurs in the fanglomerate near its western edge, or at its western edge, for a distance of approximately 12 miles. It has an average thickness of 100 feet. According to Kingery "This body is a medium grained, highly epidotized and chloritized green metagabbro." It has altered locally the fanglomerate and some of the rocks of the western facies. As none of the Triassic rocks are metamorphosed it is hard to believe that this $\frac{1}{2}$ dike can be a metagabbro, as it is undoubtedly of late Triassic age and has intruded unmetamorphosed rocks. The fanglomerate grades upward into the younger facies.

Third: A western facies, which extends along the western border of the Triassic Basin from northeast of Keene to the vicinity of Mt. Zion Church. In places this western facies is almost a mile wide. The best exposures are on Highway 6, 4 miles west of Scottsville, and on Highway 20, $1\frac{1}{2}$ miles

southeast of Keene. This western facies is composed of red, gray and green silty sandstones and occasionally pebble conglomerates.

The Scottsville Basin is bordered on the west by normal faults occurring in a fault zone, which is well exposed 4 miles west of Scottsville on Route 6, 1½ miles southwest of Keene on Route 20. All of the sediments dip to the west, having a maximum dip of 55° near the eastern border and a dip of approximately 5° near the western border. The average strike is N. 35° E.

The eastern edge of the Scottsville Triassic basin is bordered by a normal fault, except in the northeast corner of the basin where the Triassic beds lie unconformably on the Loudoun formation of Cambrian age. One horst of Loudoun sediments occurs in the northeast corner of this Triassic basin.

Two offsets occur on the northwest edge of the basin, exposing Catoclin greenstone. One of these offsets extends from Mt. Zion Church to the Chesapeake and Ohio Railway and approximately ½ mile southwest of the railway. The second offset occurs 1¾ miles southwest of the railway and is roughly parallel to Highway 626 for a distance of 2¼ miles. In the first offset a 300 foot diabase dike is offset approximately ½ mile by the fault bordering the Triassic basin on its northwestern side.

No interbasin faults were observed in the Scottsville basin. None of the diabase dikes mapped show any offsets except along the northwestern edge of the basin.

CAMBRIAN AND PRECAMBRIAN CONTACT

The Catoctin greenstone has, in the past, been considered the topmost member of the Precambrian rocks in Virginia, and the Loudoun (Unicoi) formation the basal member of the Cambrian. In recent years detailed field work in Albemarle County and adjacent areas, and age determinations made on different rocks in the southern Appalachians, indicate that the top of the Precambrian in this part of Virginia should be the Virginia Blue Ridge complex which makes up the core of the Blue Ridge Mountains in this county and covers the surface of the county from the foot of the Blue Ridge to the Mechum River belt of metamorphosed rocks. In places granites have been injected into this complex.

Detailed sections along the western side of the Blue Ridge from the top of the overturned Catoctin to the Erwin quartzite show the following relationships: Immediately on top of the Catoctin greenstone there is a slightly metamorphosed, arkosic sandstone conglomerate (10 feet) containing quartz pebbles ranging up to 1 inch in diameter. No pebbles or fragments of greenstone occur in this basal conglomerate.

Above this basal conglomerate there occur 560 feet of basal Loudoun (Unicoi) composed of three Catoctin-type lava flows separated by coarse arkosic quartzitic sandstones capped by a 175 foot metamorphosed acid lava flow. These rocks have been mapped in the past as basal Cambrian rocks belonging to the Unicoi formation.

Northward from Albemarle County and just south of Thornton Gap, the metasediments between the three lava flows in the basal Unicoi are completely metamorphosed and decrease in thickness. The lava flows increase in thickness, so that in this part of the Blue Ridge, 30 miles north of Albemarle County, all of these rocks have been mapped as the upper part of the Catoctin (Reed, 1955). They are well exposed on the Appalachian Trail under Crescent Rock, just south of Skyland.

The altered acid lava flow occurring approximately 500 feet above the base of the Unicoi in the Waynesboro, Virginia, section is mapped as the top of the Catoctin.

In the Waynesboro section there are 1,425 feet of coarse and fine grained micaceous sandstones, shaly sandstones and glassy ferruginous sandstones containing several beds of siliceous hematite which occur above the metamorphosed acid lava flow, and are referred to as Middle Unicoi. Above

the Middle Unicoi there are 225 feet of pink and yellow paper-bedded shales, overlain by 825 feet of sandy shale, shaly sandstone and thin sandstone layers, referred to as the Upper Unicoi. There is an angular unconformity between the Unicoi and the Erwin quartzite.

This field evidence is part of the basis for placing the base of the Cambrian on the eroded top of the Unicoi, where an angular unconformity, with a dip of 24° , occurs and the Harpers shale has been removed by erosion.

The Unicoi, Catoctin and Swift Run formational units occur below the main fossiliferous Paleozoic rocks and above the top of rocks with definite pre-Cambrian age.

Stose (1954) found well preserved fucoids in slate of the Virgilina series near Zebulon, North Carolina, east of Raleigh. G. S. Cooper states they are Paleozoic fossils. The Virgilina series is primarily a greenstone and considered to be the eastern extension of the Catoctin greenstone.

Howard W. Jaffe has determined lead-alpha activity ages of zircons at three places in the Virginia Piedmont. The localities and the type of rock tested are as follows: The granitic gneiss near Sperryville, Virginia, the Old Rag granite in the Stony Man quadrangle and the hypersthene granodiorite near Mile Post 21 on the Skyline Drive. These rocks have ages of 470 million years, 410 million years and 560 million years respectively.

Urey (Lane, 1935) using the helium method, determined the age of the amygdaloids in the Unicoi as approximately 450 million years old.

Samples of the Virginia Blue Ridge complex were collected from dumped material from the north end of Mary's Rock tunnel on the Skyline Drive, south of Thornton Gap, near the junction of Madison, Rappahannock and Page counties, approximately 30 miles north of Albemarle County. Age measurements have been made on muscovite, biotite, zircon, etc., by Tilton, Wetherill, Davis and Bass (1960) from this rock. Determinations from zircon were from 1070 to 1150 million years and from biotite mica were from 800 to 880 million years.

All of these age relationships indicate that the top of the Precambrian rocks should be the eroded surface of the Virginia Blue Ridge complex upon which the Swift Run formation was laid down. The rock layers between the base of the Harpers shale and the top of the Virginia Blue Ridge complex lie between the base of the fossiliferous Cambrian and the top of the Proterozoic.

IGNEOUS ROCKS

TABULAR SHAPED BODIES

ALASKITE DIKES

An alaskite dike occurs on the east side of Southwestern Mountain, outcropping on Highway 53 between Monticello and Simeon. This is an igneous rock consisting of orthoclase, microcline, and subordinate quartz, with few or no basic constituents. This dike was described by Lambeth (1901), and later correctly identified by Lewis (1926). It is about 20 feet wide and has been traced in a northeast-southwest direction for a short distance on either side of the highway.

A 20 foot alaskite dike was described by Moore (1931) $\frac{1}{2}$ mile south of Carter Bridge on Highway 20, where a small quarry was opened years ago. As both of these dikes cut the Catoctin greenstone their age can only be stated to be Post-Catoctin.

AMPHIBOLITE DIKES

Numerous amphibolite dikes occur in Albemarle County. These dikes are composed of crystalloblastic rock consisting mostly of amphibole and plagioclase. Quartz is absent, or present in small quantities.

A very well defined and wide amphibolite dike extends in a northeast-southwest direction for a number of miles north and south of Charlottesville. It outcrops on the University of Virginia grounds, the original Jeffersonian Village, or Lawn, being underlain by this dike which, at this point, is 830 feet wide. It is referred to as the University amphibolite dike.

This dike is bordered on its northwest-southeast sides by faults, a high angle reverse fault on its northwest side and a normal fault on its southeast side. The normal fault on its southeast side is well exposed in the Southern Railway cut 500 feet east of Shamrock Road crossing. The high angle reverse fault on its northwest side was well exposed at the Junction of Emmett Street and Jefferson Park Avenue but has now been covered by a masonry wall.

The northernmost outcrop of the dike is just about one mile north of Stony Point, while its southernmost outcrop is on Ammonett Mountain just north of Johnson Mill.

A narrow amphibolite dike extends almost north and south from this main dike, starting in Lambeth Field at the University of Virginia and thinning down to where it cannot be traced in the vicinity of the Albe-

marle Training School just south of the Rivanna River. This dike shows baked sediments on both of its edges, where it was exposed in the excavations made at the time Lambeth field was constructed for the University of Virginia (Lambeth, 1901).

A sixty foot amphibolite dike, extending in a northeast and southwest direction, is well exposed in the City of Charlottesville at the foot of Beck's Hill and at the western foot of the ridge on which Ridge Street is located. It has been traced southwestward about 4 miles from Beck's Hill in Charlottesville and northeastward from Charlottesville to the vicinity of Rio.

Many narrow amphibolite dikes, less than 100 feet wide, outcrop in the belt between Southwestern Mountain and Mechum River. They are exposed in many road cuts in this belt. South of Charlottesville there are several well defined dikes, one on Route 29 at Crossroads and several others on Highway 712 at South Garden.

The southern end of the University amphibolite dike is faulted a number of times in the Hardware River area, where a large block of amphibolite, $\frac{1}{2}$ mile wide by $1\frac{1}{4}$ miles long, is bordered by almost east-west faults on its north and south sides and by other faults on its east and west edges. The southern faulted end of the University amphibolite dike extends from Mt. Olivet School to the northern end of Ammonett Mountain, being bordered by faults on all sides.

Another wide amphibolite dike crosses Highway 25 one mile southwest of the Albemarle County line, and extends in a northeast direction into the county to Rich Cove Creek.

Other amphibolite dikes occur in the northern part of the county near Burnleys, Gilbert, between Earlysville and Advance Mills, and on the northeast edge of Piney Mountain.

As the amphibolite dikes are not as highly metamorphosed as the metapyroxene soapstone dikes, it is considered that they are related to the Taconic orogeny. A geological map by Gravatt (1920) states that the amphibolite dikes around Charlottesville are post-Cambrian in age.

DIABASE DIKES

Many diabase dikes occur in Albemarle County. They are of basaltic composition, consisting essentially of labradorite and pyroxene, and characterized by ophitic texture. They are often so thoroughly weathered that they can only be identified by dark red residual soil containing

weathered spheroidal boulders. They are grayish black to black in color, massive, hard, and very dense, being fine grained on the edges and coarse grained in the center. Most of these dikes extend in almost a north-south direction across part of the county. There is one dike, over 300 feet wide where it crosses the James River on the south edge of the county, which extends entirely through Albemarle County and into Greene County, where it had thinned down to a thickness of 20 feet and could no longer be traced northward. This dike has been offset in many places, particularly on the northwestern edge of the Scottsville Triassic Basin, again just north of where it crosses Highway 29 near the western edge of Charlottesville, again on Highway 658 just south of Slaughterpen Creek.

Many of these diabase dikes are shown on the geologic map, but there are many others which are less than 50 feet thick and have only been seen in artificial excavations and could not be traced across the county. None of these have been placed on the geologic map.

There are several well defined diabase dikes in the vicinity of Crozet which have been traced for a number of miles. Another diabase dike occurs on Route 250 at Limestone Creek, cutting the Everona limestone. Numerous dikes occur in the Scottsville Triassic basin. Other dikes outcrop off Highway 29 at Cove Creek, and on Highway 683 at Bethel Church, on Highway 635 at the entrance to the Miller School, on Highway 696 north of Tom's Mountain, on Highway 674 south of Pigeon Top Mountain, and three dikes on Highway 668 between Montfair and Wesley Chapel.

Diabase dikes cut every formation occurring in Albemarle County, from the eastern edge of the county near Boyd's Tavern Post Office to Rockfish Gap just west of the western edge of the county. A dike cuts through this gap in the Blue Ridge Mountains in a direction slightly west of north into Augusta County, and in a direction slightly east of south into Nelson County.

Diabase dikes likewise occur from the southern edge of the county on the James River to the north boundary of the county.

As these dikes cut all the Triassic rocks in the Scottsville Basin, they are probably of late Triassic age, and not younger, as one of the largest dikes is offset by northwest-southeast faults which are of Triassic age.

As the diabase dikes cut all sedimentary and metamorphic rocks, with the probable exception of the felsite dikes, and they are definitely associated with Triassic rocks, they are considered to be of late Triassic age.

FEEDER DIKES

Feeder dikes is the name given to the fissure dikes through which the basaltic material flowed up to the surface to produce the Catoctin lava flows. They were described by (Reed, 1955), as occurring on the Skyline Drive north of Albemarle County.

They occur in this county in the Fox Mountain area where they cut through the Virginia Blue Ridge complex. Four of these dikes have been seen. One is on Highway 668, between Mountfair and Wesley Chapel, is 200 feet wide with a strike of N. 3°E., approximately 1.4 miles east of the Mountfair Post Office. A second dike is about 0.6 mile east of the first dike, is 50 feet wide and with the same strike. Other outcrops occur on the small road extending from Highway 668 northward across High Top Mountain, Martins Mountain and Gibson Mountain and back to Highway 671 about 1½ miles north of Wesley Chapel. One 200 foot dike occupies the saddle between Martins Mountain and Gibson Mountain. It is 200 feet wide and has a strike of N. 26°E. Another dike occurs on the south side of Gibson Mountain, is over 50 feet wide with a strike of N. 45°E.

There are undoubtedly more feeder dikes which were not seen.

No dips could be obtained due to weathering but the dikes appeared to be almost vertical.

No feeder dikes have been found cutting the formations which occur below the Catoctin greenstone in the Southwestern Mountain area. As the rocks have almost vertical dips in this area, such dikes might be parallel to the surface of the ground and not uncovered by the slight erosional relief existing in the county between Mechum River and Southwestern Mountain.

FELSITE DIKES

Felsite dikes occur in many places in Albemarle County. They are a light colored, igneous rock, with or without phenocrysts, in which either the whole, or the ground mass, consists of a cryptocrystalline aggregate of minerals, quartz and potassium feldspar being the minerals characteristically developed. The rock weathers very easily and it is difficult to map these dikes. When unweathered they have a buff, or light tan, color which weathers to a cream or nearly white colored rock with iron stained joints.

These dikes are from 66 feet in thickness to a few feet in thickness and may extend in any direction across the country. In general they extend in a northeast-southwest direction.

A felsite dike, 66 feet wide, was uncovered in the trench dug for the natural gas line into Charlottesville in 1950, at a distance of 585 feet southeast of where the pipe line trench crossed Highway 743 near the Albemarle Training School.

Most of these dikes occur in the western edge of Charlottesville and northward to the county line just south of Burnley.

At only one place, just north of secondary highway 658 off of Barracks Road, is there a partially covered outcrop of a diabase dike and a felsite dike. At this point the obscured relationships indicate to the author that the felsite dike cuts the diabase dike.

At the Stony Point copper mine a northeast-southwest fault, of probably late Triassic age, is filled by a felsite dike. Late Triassic faults having this same general strike, offset a thick diabase dike on the north edge of the Triassic basin west of Esmont. This is additional evidence that the felsite dikes are younger than one of the large diabase dikes, and may be of very late Triassic age.

A good exposure of two felsite dikes occurs on State Highway 743, about 100 yards south of Hydraulic, in the Southern Railway cut just south of the bridge over the railway tracks leading to Fry Spring in the southeast edge of Charlottesville and in the Southern Railway cut north of Rio where State Highway 651 crosses the railway. There are many other felsite dikes northeast of Charlottesville in the area between Highway 29 and Highway 20 to the Orange and Greene County lines. Another good outcrop occurs on Highway 641 slightly over $\frac{1}{2}$ mile east of Burnley.

GABBRO DIKE

A gabbro dike occurs in the Triassic fanglomerate near its western edge in the Scottsville Triassic basin. It is approximately 12 miles long, and has an average thickness of 100 feet. According to Kingery (1954), "It is a medium grained, highly epidotized and chloritized green metagabbro." As this dike is of Triassic age, it can hardly be metamorphosed. It is well exposed on Highway 713, about 100 yards from its intersection with Highway 20 near Glendower. A sample taken at this location by the author is reported by Mr. Baetcke to be a diabase dike of extremely fine grained texture, obscured by intense epidotization. The pyroxene is almost completely altered to chlorite. The subophitic texture indicates that the rock is a diabase. The mineral constituents in this sample are epidote, plagioclase feldspar, chlorite, ilmenite, magnetite and quartz.

METAPYROXENITE DIKES

A number of metapyroxenite dikes occur in the southern part of the county, extending from the Nelson County line northeastward toward Charlottesville. All but two of these dikes thin down and disappear before reaching Charlottesville. They are medium or coarse grained, metamorphosed rocks consisting essentially of pyroxene. They have been altered in places by hydrothermal action to form the soapstone dikes of Albemarle County.

Four of these soapstone dikes have been worked rather extensively at different places in the southern part of the county.

Where hydrothermal alteration has taken place this rock is composed of chlorite, talc, tremolite, serpentine and some calcite with a few accessory minerals.

The major soapstone dikes are from 160 feet to 100 feet wide, thinning down greatly as they extend northward. At the town of Alberene, on Highway 719, near the northern limit of the soapstone area where one of these dikes was first worked, it has a thickness of about 100 feet.

Some of the rock produced from these dikes, where it contains large amounts of serpentine, is sold as serpentine. The remainder is sold as soapstone.

Most of these dikes occur in the Charlottesville formation, but one occurs near the top of the Swift Run formation between Hartman's Mill Road and Pollocks Branch, so they are younger than the Swift Run formation, and older than the Catoctin as none of them cut this greenstone.

LIGHT COLORED AMPHIBOLITE DIKE

One light colored amphibolite dike occurs in the county just south of Charlottesville, to the west of Southwestern Mountain on an old road extending southwest from Mayo Chapel. This dike is about 50 feet wide and has been traced for a distance of several miles into the southern edge of Charlottesville. It has not been described or listed in any previous geological reports. It is composed of 50 percent amphibole, 25 percent chlorite, 20 percent epidote and 5 percent quartz, as determined by the Virginia Division of Mineral Resources. This dike occurs in the Swift Run formation.

STRUCTURE

GENERAL STATEMENT

All of Albemarle County lies east of the crest of the Blue Ridge Mountains, but its structural features are features existing in the Blue Ridge and Piedmont physiographic provinces of Virginia. A large part of this county lies in the Southwestern Mountain-Blue Ridge anticlinorium, first recognized by Keith (1892) and called the Catoctin-Blue Ridge anticlinorium.

To the southeast of this anticlinorium there occurs a narrow synclinal belt known as the Everona syncline, as the axis of this syncline is occupied by this limestone formation.

Albemarle County, therefore, contains only two major structural units, the Southwestern Mountain-Blue Ridge anticlinorium and the Everona syncline. The Southwestern Mountain-Blue Ridge anticlinorium is very complex and has never before been mapped in detail. The Everona syncline is a very simple structural feature, which was first recognized by Jonas (1927) where the northern extension of this belt of rocks outcrops in Maryland and Virginia.

SOUTHWESTERN MOUNTAIN-BLUE RIDGE ANTICLINORIUM

The rocks forming the core of this anticlinorium are separated into two distinct belts by the Mechum River formation belt, a down-dropped graben extending in a northeast-southwest direction, and following, in Albemarle County for most of its distance, the course of Mechum River. Between Southwestern Mountain and Mechum River the core rock is Lovingsston gneiss, with associated granitic and pegmatitic injections. To the west of Mechum River the core rock is composed of the Virginia Blue Ridge complex which includes granodiorite, hypersthene granodiorite and granitic injections.

The eastern edge of the Lovingsston gneiss is marked by a well defined border fault, paralleling the edge of the Lovingsston gneiss and, in places, bordering the gneiss on its eastern edge. This fault dips steeply to the west and, in places, has thrust the Lovingsston gneiss over part of the Rockfish conglomerate.

The western edge of the Lovingsston gneiss is marked by a high angle thrust fault which forms the eastern side of the Mechum River graben. The eastern half of this anticlinorium has been thrust upward and westward to form the beginning of a great recumbent fold, an alpine-like structure.

The eastern half of this recumbent fold is broken by two faults which bound the Mechum River graben on its east and west sides. The western half of this recumbent fold has its core rock, the Virginia Blue Ridge complex, folded into the end of this recumbent fold.

Numerous drag folds of considerable magnitude have been mapped in this part of the recumbent fold, particularly in the Fox Mountain dome section where layers of the Swift Run formation form parallel, curved drag fold belts. Some of these belts may have been faulted by high angle thrust fault movements.

The sediments occurring on top of the core rock in the western part of this recumbent fold are in ascending order, the Swift Run formation, the Catoctin greenstone, and the Unicoi (Loudoun) formation. They compose the Blue Ridge Mountains and they are all overturned.

The Catoctin forming the crest of the mountain lies on top of the Unicoi (Loudoun) which forms most of the western slope of the Blue Ridge. On the upper western slopes of the Blue Ridge the contact between the Catoctin greenstone and the Unicoi (Loudoun) formation has an average dip to the southeast of 45° , while this same contact in the Chesapeake and Ohio Railway tunnel under the Blue Ridge, 600 feet lower, has a dip of 60° to 70° to the southeast. These dips can most readily be accounted for if the Southwestern Mountain-Blue Ridge anticlinorium is composed of a recumbent fold.

The most striking structural feature of the western part of Albemarle County is the Fox Mountain dome, composed entirely of the core rock

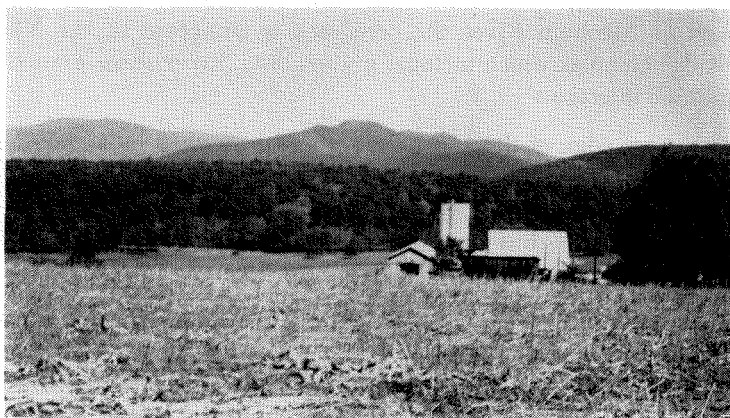


FIGURE 12. Fox Mountain dome, looking north from White Hall.

of the western part of the anticlinorium which, in this section, is the Virginia Blue Ridge complex (Figure 12). Surrounding this dome, which is $7\frac{1}{2}$ miles long and $5\frac{1}{2}$ miles wide, are infolds of the Swift Run formation. In the mountains themselves there are several 200 foot wide feeder dikes which were the source of some of the lava which formed the Catoctin greenstone.

The metasediments lying above the core rock of the Southwestern Mountain-Blue Ridge anticlinorium in its eastern half, east of Mechum River, are, in ascending order, the Rockfish conglomerate, the Lynchburg gneiss (restricted), the Johnson Mill slate, the Charlottesville formation, the Swift Run formation, the Catoctin greenstone and the Loudoun formation (Unicoi).

The core rock, the Lovington gneiss, was base leveled. On this submerged basement complex was deposited the Rockfish conglomerate. The Rockfish conglomerate is composed of metamorphosed sediments, the characteristic feature being that the sediments are all coarse grained, predominantly sandy, and contain boulder beds at its base.

Above the Rockfish conglomerate there occur several thousand feet of very silty-like metamorphosed sediments, which, at the base, are composed of rhythmically banded graphitic feldspathic and sericitic slates. The upper part of this formation is composed of fine grained quartz biotite gneiss in layers several feet thick. As this formation is faulted in several places, and likewise folded, no true thickness can be given but it must be of the magnitude of several thousand feet.

The folding which occurs in the Lynchburg formation (restricted) does not extend into the overlying formation, the Johnson Mill graphite slate. The Johnson Mill graphite slate is approximately 300 feet thick and extends in almost a continuous belt from the southern edge of the county on Route 6, near the Nelson County line, to the Greene County line, a few miles west of Barboursville.

In the southern part of the county this graphite slate lies east of the University amphibolite dike. In the northern part of the county it lies to the west. It crosses the amphibolite belt in Charlottesville, where only 50 feet of graphite schist is exposed on the eastern side of the fault bounding the amphibolite dike on the southeast. This formation contains pyrite stringers throughout its entire length. They are best exposed at the type locality at Johnson Mill.

Lying above this formation is the Charlottesville formation, so named because a large part of Charlottesville is underlain by these rocks. This

formation is composed primarily of thick beds of quartz biotite gneiss which weather to a silty, tan colored loam. There are a few interbedded layers of sericitic and graphitic schist. The formation has a thickness of 4,300 feet at its type locality in Charlottesville.

Lying unconformably above this formation is the Swift Run formation, which is distinguished from the Charlottesville formation by the predominance of coarse blue quartz. Its lower part is composed of conglomeratic, quartzitic sandstones containing blue quartz pebbles up to $\frac{1}{2}$ inch in diameter. These layers are approximately 300 feet thick, then a 50 foot amphibolite dike occurs, and above it 600 feet more of predominantly coarse quartzitic sandstone with much blue quartz.

Above these massive beds there occur about 1,100 feet of coarse and medium grained metamorphosed sediments. In the top part of this formation there are two greenstone lava flows 40 to 50 feet thick, separated by a 2 foot layer of altered volcanic ash. At the top of the formation there are several layers of sericite schist containing perfect magnetite crystals about one millimeter in diameter and a 5 foot metapyroxenite dike. The total thickness of the Swift Run formation in Charlottesville is approximately 2,250 feet.

Lying on top of the Swift Run formation is the Catoctin greenstone, which comprises a belt of rocks approximately $3\frac{1}{2}$ miles wide, extending in a northeast-southwest direction and making up Southwestern Mountain. On its western edge it has a dip of approximately 70° to the southeast, while on its eastern edge it dips practically vertically into the earth.

There appears to be an angular unconformity between the rocks forming the Swift Run formation and the basal greenstone flows of the Catoctin. This contact is exposed in a cut on the Highway 250 bypass around Charlottesville, on the west side of the creek on the west side of Locust Avenue.

These metamorphosed sediments and lava flows, which lie on top of the core rock of the eastern half of the Southwestern Mountain-Blue Ridge anticlinorium, have a thickness of the magnitude of 60,000 feet, which represents the thickness of the sediments and lava flows making up the geosyncline out of which the great recumbent Southwestern Mountain-Blue Ridge anticlinorium was formed.

EVERONA SYNCLINE

The axis of the Everona syncline occurs east of Southwestern Mountain and is the other major structural feature occurring in Albemarle

County. The axis of this syncline is occupied by the Everona limestone, which is considered to be of late Cambrian age.

The Everona syncline was first described as a syncline by Nelson (1954). This syncline was interpreted as being overturned and compressed. Numerous drag folds, exposed in a deep cut on Route 53 between Charlottesville and Palmyra, just west of the limestone outcrop, indicate this structural interpretation. Similar pink bedded slates occur to the west and east of the Everona limestone.

Lying east of Southwestern Mountain there are two broad belts occupied by the Loudoun formation on either side of the Everona limestone. The Loudoun formation, lying to the east of the Everona limestone, extends beyond the boundary line of Albemarle County.

In places the contact between the Loudoun formation and the Catoctin greenstone along the eastern foot of Southwestern Mountain is faulted. Where faulting does not occur the basal Loudoun formation exposed around Simeon is a coarse sandstone conglomerate containing pebbles of quartz, greenstone and rhyolite (Lambeth, 1901). To the northeast, around Shadwell, pink paper bedded shales occur immediately on top of the Catoctin. In Orange County, on the road from Highway 231 to Madison Run Station, a lense of marble 65 feet thick occurs in the Loudoun 370 feet above the Catoctin greenstone.

FAULTS

Faults occurring in Albemarle County are of the following types:

1. A high angle thrust fault, occurring near the crest of the Blue Ridge, thrusting the Catoctin greenstone over part of the Unicoi formation.
2. Border fault along the eastern edge of the Lovington pre-Cambrian basement complex.
3. High angle reverse faults striking northeast and southwest, of varying ages from pre-Cambrian to Pleistocene.
4. Normal faults striking northeast and southwest, of varying ages, probably from pre-Cambrian to post-Triassic.
5. Normal faults striking northwest and southeast of post-Triassic age, younger than the post-Triassic faults striking northeast and southwest.
6. Normal tension faults striking almost north and south, but varying a few degrees in places, either to the east or west, generally to the east. In all places, these tension faults are filled with diabase dikes of Triassic age except in the northwest edge of Charlottesville where one is filled by an amphibolite dike.
7. Normal faults having an almost east-west strike.

HIGH ANGLE THRUST FAULT

A high angle thrust fault occurs along the crest and near the crest of the Blue Ridge in Albemarle County from Calf Mountain northward to the Greene County line. This fault dips steeply to the southeast and has crumpled into compressed anticlines and synclines, the Unicoi formation lying to the northwest of this fault. The Catoctin has been thrust over part of the Unicoi. This fault crosses the Skyline Drive at Calf Mountain, again slightly over one mile north of Browns Gap, and, finally, on the southwest side of Loft Mountain. The rocks on the north side of Eppert Hollow, when viewed from the Skyline Drive, show well developed drag folds in the Unicoi.

BORDER FAULT

Along the eastern edge of the Lovingson gneiss there is a well developed typical border fault which is so often found on the edge of large batholiths. This fault dips steeply to the west and is well exposed on Route 29, on the western edge of Charlottesville, where the fault zone of approximately 50 feet is composed of a biotite schist with washboard structure. At this point, the lower part of the Rockfish conglomerate is absent and, presumably, has been faulted out. This border fault has been traced southward into Amherst County.

Along the Rockfish River, at the type locality of the Rockfish conglomerate, the border fault does not follow the contact between the Lovingson gneiss and the Rockfish conglomerate. It cuts into the Lovingson gneiss several hundred feet to the west of this contact. Just east of Amherst, the border fault has cut out all of the Rockfish conglomerate except at one place where the upper part of this conglomerate remains to form an elliptical quartzitic sandstone conglomerate outcrop.

To the north of Charlottesville the border fault roughly follows the contact between the Lovingson and the acid granite which has replaced all of the Rockfish conglomerate. This fault crosses the Greene County line just west of Piney Mountain.

HIGH ANGLE REVERSE FAULTS

A high angle reverse fault was well exposed, until covered by a retaining wall, on the west side of the University amphibolite dike on the edge of the University grounds, at the intersection of Emmett Street and Jefferson Park Avenue. This amphibolite dike, which has been mapped throughout most of Albemarle County, and which extends in a northeast-southwest direction, is bordered by this high angle reverse fault wherever exposures

occur at this contact. This high angle thrust fault occurs in a fault zone having an east-west width of about two miles. To the west of it, just west of the intersection of Route 29 and Barracks Road, is another high angle thrust fault exposed in a barrow pit, which has a dip of 72° to the northwest and a strike of N. 39° E. Twenty-four feet west of this fault is a normal fault, dipping 60° to the southeast, also exposed in this pit. This fault has displaced a narrow amphibolite dike 1,400 feet horizontally. The cut, which is approximately 25 feet deep, shows no matching of the banded slates which occur on either side of the fault, so there is at least a 25 foot vertical displacement, and probably much more. This fault is offset by northwest-southeast faults at four different places in the north-western edge of Charlottesville.

The fault which produces the maximum horizontal displacement crosses Route 29 slightly over $\frac{1}{2}$ mile south of Barracks Road intersection. It produced a horizontal displacement of 400 feet.

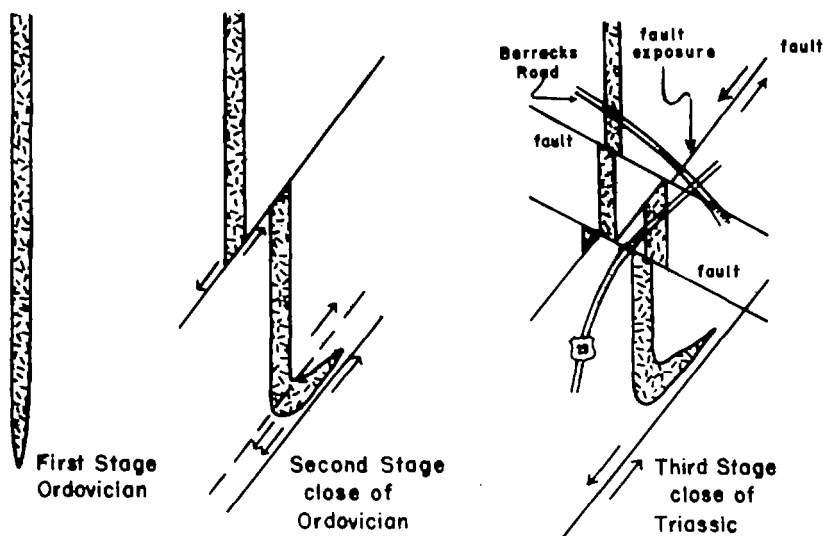
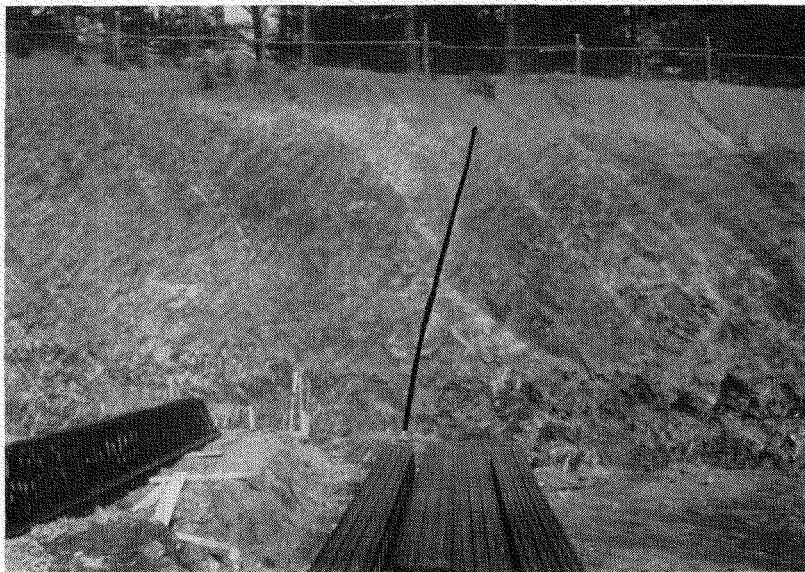


FIGURE 13. Development of complex faults in Barracks Road Shopping Center.

Figure 13, showing the first stage where the north-south fault was filled with an amphibolite dike, probably during Ordovician time. The second stage shows the development of two high angle thrust faults offsetting and folding this dike. This movement is believed to have taken place at the

close of the Ordovician period. The third stage shows the fault pattern, with the offsets in the amphibolite dike caused by faulting which occurred at the close of the Triassic (Figure 14).



Courtesy of R. S. Young

FIGURE 14. Fault exposure at north end of Barracks Road Shopping Center, Charlottesville. Location of fault exposure noted on Figure 13, third stage.

Between Greenwood and the foot of the Blue Ridge on Route 250, there is another zone of high angle reverse faulting about a mile wide, in which at least four high angle reverse faults were located, but on only one of these faults could the displacement be measured. This fault was on the highway cut at the entrance to "Tiverton," and showed a five foot displacement of Pleistocene terrace gravel, the gravel having been dragged down into the fault plane (Figure 15).

It is only where artificial exposures have been made in the Piedmont that, as a rule, the presence of high angle thrust faults can be detected.

These high angle reverse faults differ from the high angle thrust fault occurring in the Blue Ridge Mountains. They produce no drag folds on the underthrust side, but do produce a slight upward drag of the bedding planes next to the fault on the underthrust side. It is possible that these faults are underthrust faults.

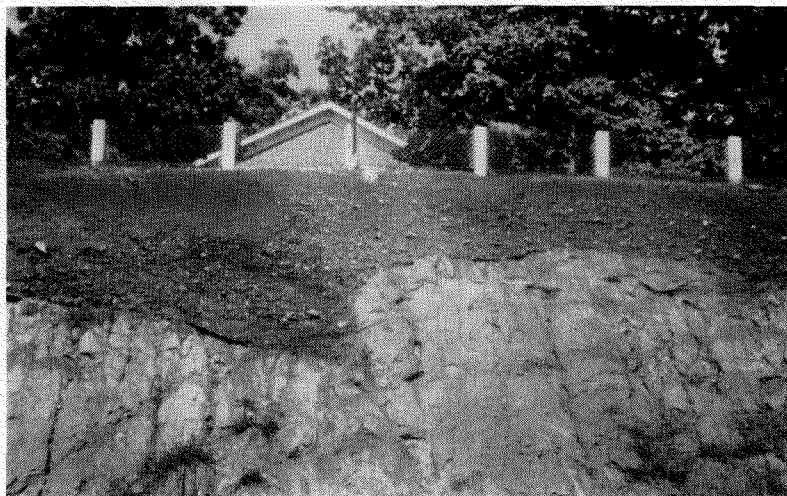


FIGURE 15. Five foot displacement of terrace gravel in Pleistocene fault at Lebanon Church on U. S. Highway 250 south of Greenwood.

NORMAL FAULTS STRIKING NORTHEAST AND SOUTHWEST

Normal faults striking northeast and southwest have been mapped throughout the entire Piedmont of Virginia. Some of these normal faults probably started in pre-Cambrian time and have been active up to post-Triassic time.

Bordering the University amphibolite dike on the eastern side is a normal fault having a slight dip to the southeast. This normal fault is considered to be of pre-Cambrian age and wherever exposures occur, it is seen to border the University amphibolite dike on its east side, throughout Albemarle County.

Similar faults border, on their west sides, all of the five Triassic basins which occur in the Piedmont of Virginia. In the Richmond Triassic basin these faults also occur on the east side of this basin. The same thing is true in the Triassic areas around Orange.

Some of these faults have been active since Triassic time as they are known to displace Triassic diabase dikes where the dikes extend from the Triassic basin into adjacent Piedmont rocks. This is true between $2\frac{1}{2}$ and $3\frac{1}{2}$ miles south of Esmont on the northwestern side of the Scottsville Triassic basin.

NORMAL FAULTS STRIKING NORTHWEST AND SOUTHEAST

Normal faults striking northwest and southeast have been mapped as bordering the Richmond coal basin at its north and south ends, also bordering the James River Triassic basin on its north end, and the Barboursville basin on its south end.

In the area between the Barboursville and Scottsville Triassic basins, similar faults have been found to affect the topography in parts of Albemarle County and to offset the metapyroxenite, amphibolite, diabase and felsite dikes which have been mapped in this area. One of these faults, in the western edge of Charlottesville, offsets a northeast-southwest normal fault a distance of 400 feet. This offset can be measured due to the fact that it cuts and offsets a small amphibolite dike which had already been offset 1,400 feet by the northeast-southwest high angle thrust fault.

NORMAL TENSION FAULTS EXTENDING IN A NORTH-SOUTH DIRECTION

This north-south normal fault designation is inferred from the major structural movements to which the Piedmont of Virginia has been subjected.

One such fault, occurring in the northwestern part of Charlottesville, is filled by an amphibolite dike which has baked the wall rock on either side. All other faults of this type are filled by diabase dikes of Triassic age.

The one Charlottesville fault indicates the north-south faults which opened up during Triassic time were, at least in part, formed by regional tension at the close of Ordovician time, after the first folding of the Southwestern Mountain-Blue Ridge anticlinorium took place. This dike, and the other amphibolite dikes, are considered to be of Ordovician age.

From the close of Ordovician time to Permian time, the present Piedmont region of Virginia was subjected to a continuous gentle westward downwarping. After Permian time this westward downwarping stopped and downwarping then started to the east of the present Piedmont. The entire eastern part of what was then the North American continent in the Virginia area was downwarped to permit the overlapping of the continent from the east to the west by sediments younger than Permian. This eastward downwarping started during Permian times and made a structural arch out of the Piedmont region of Virginia, and this major structural arch caused the reopening of north-south tension cracks extending a few degrees east of north which were formed during the Taconic Revolution. In these reopened tension cracks, along which it is assumed movement took place, there are now numerous large Triassic diabase dikes, some of

which have been traced for over 50 miles and have a maximum width of over 300 feet.

NORMAL FAULTS HAVING AN ALMOST EAST-WEST STRIKE

All of the normal faults have already been discussed, except a few which have an almost due east-west strike. Such faults border some of the Triassic areas in Virginia. The southern end of the Culpeper basin, lying in the northern edge of Albemarle County, is bordered by two such faults. Two additional east-west normal faults border a faulted mass of amphibolite which occurs on Highway 708 between Red Hill and Mt. Olivet Church.

MECHUM RIVER GRABEN

There is one well developed graben area in this county. Throughout most of its distance Mechum River flows in this graben valley. The two faults bordering this graben occur 0.7 miles apart, from its southern end to where Highway 614 from Charlottesville to Whitehall crosses the graben. North of this point the graben becomes much wider and has a width of approximately 1.3 miles to the Greene County line. The southern end of the graben is at Sharp Top Mountain about two miles southwest of Batesville. The graben faults have a strike varying from N. 40°E., to N. 45°E.

In the structural cross section across the Southwestern Mountain-Blue Ridge anticlinorium this graben is shown as bordered by a high angle thrust fault on its eastern side and a normal fault on its western side to produce the down-dropped Mechum River graben. There is a wide shear zone in the rocks bordering this graben on both sides.

ANGULAR UNCONFORMITIES

Lying unconformably on the Lovingson quartz monzonite, commonly referred to as the basement complex, is the Rockfish conglomerate (Nelson, 1932), approximately 1,200 feet thick at its type locality, the lower hundred feet containing large, rounded boulders of Lovingson gneiss which rest on the eroded surface of this formation. This is a major angular unconformity separating the Archean rocks from the overlying Proterozoic rocks.

The next angular unconformity is at the contact between the Lynchburg gneiss (restricted), in Albemarle County, and the overlying Johnson Mill graphite slate formation. The Lynchburg gneiss is folded into anticlines and synclines. Due to this folding the geologic map of Albemarle County

shows this formational belt to vary in thickness, increasing in thickness toward the north. The overlying Johnson Mill formation, which averages 300 feet in thickness, is shown on the map as a narrow, almost straight, line from the southern to the northern boundaries of Albemarle County, except where it is faulted out by the University amphibolite dike and offset by faults in the northern part of the county. If the Johnson Mill formation was involved in the folding to which the Lynchburg gneiss was subjected it would not show on the map as a narrow straight line. It was, therefore, laid down on the folded and eroded surface of the Lynchburg gneiss.

The next unconformity occurs at the base of the Swift Run formation. This is a very prominent and important unconformity in the western part of the county. Swift Run sediments and volcanics were laid down on a submerged land surface of very irregular relief, submerged very quickly, before base leveling had started. Differences in relief of over 1,200 feet have been measured in the Blue Ridge from just north of Albemarle County to the Nelson County line. Submerged hills, or small mountains, had their valleys buried so that Swift Run sediments and volcanics extended from mountain top to mountain top. At the southern end of Pasture Fence Mountain the Virginia Blue Ridge complex, forming the core of Pasture Fence Mountain, was buried under approximately 100 feet of sediments. At Stony Man Mountain the Virginia Blue Ridge complex lies within a foot of the base of the Catoclin greenstone.

In the eastern part of the county the rocks lying immediately beneath the Swift Run formation are the metamorphosed, silty sediments of the Charlottesville formation. From the few exposures available, it appears that the Charlottesville formation was probably base leveled and submerged before the Swift Run rocks were deposited, but sufficient relief must have existed nearby for the basal Swift Run sediments are very coarse sandstones containing many blue quartz pebbles.

The next angular unconformity occurs at the contact between the Swift Run formation and the base of the Catoclin greenstone. This is reflected on the geologic map of Albemarle County by the thickening of these two formations from south to north. The unconformity is exposed in a cut on Route 250 bypass in Charlottesville just west of the Locust Avenue overpass.

Another unconformity occurs between the Catoclin greenstone and the overlying Loudoun formation. Around Simeon the basal sandstones of the Loudoun contain pebbles of greenstone, rhyolite and quartz (Lambeth, 1901).

The most interesting angular unconformity, which involves rocks occurring in Albemarle County, is exposed just west of the county line in the first cut of the Chesapeake and Ohio Railway east of the abandoned quartzite quarry at Waynesboro, Virginia. At the top of the Unicoi (Loudoun) this angular unconformity is offset by several normal faults, all of the strata being overturned. All of the Harpers shale formation has been eroded as well as part of the top of the Unicoi formation. The Erwin quartzite rests on this angular unconformity. The bedding of the Unicoi has a dip of 28° from the Erwin quartzite layers adjacent to it. This unconformity is at the base of the fossiliferous Cambrian rocks. The rocks below are classified, in this report, as of Cambrian or pre-Cambrian age.

The final angular unconformity occurs at the base of the Triassic rocks. Part of one Triassic basin occurs on the northern edge of the county, and the other Triassic basin occurs on the southern part of the county around Scottsville. In these two areas the Triassic rocks lie on down-dropped strata of the Catoctin and Loudoun formations.

SCHISTOSITY AND GNEISSIC STRUCTURE

All of the rocks in Albemarle County exhibit, in varying degrees, either schistose or gneissic structure except the rocks of Triassic age.

The dip of the present schistosity of this area is of the magnitude of 50° to the southeast, but it may vary from around 45° to 60° .

The Lovingsston quartz monzonite is generally referred to as the Lovingsston gneiss, as it has developed varying degrees of gneissic structure.

The Virginia Blue Ridge complex has developed gneissic structure in many places.

AUGEN GNEISS

Augen gneiss is well developed in a belt about $\frac{1}{2}$ mile wide on the west side of the Mechum River graben from Route 250 to the north county line. On Highway 671, $\frac{1}{4}$ mile north of Millington, there is an excellent exposure of augen gneiss, which, on casual inspection, could be mistaken for a pre-Cambrian conglomerate. Another augen gneiss belt extends in a northwest-southeast direction along Bucks Mountain Creek on the northeast side of Buck Mountain.

FRACTURE CLEAVAGE

Fracture cleavage is well developed in the siliceous layers of Erwin quartzite which occurs on the top of Black Rock Mountain and on the Skyline Drive near the northwest corner of the county.

FALSE CLEAVAGE

Where fracture cleavage has been superimposed on schistosity it produces a crenulated structure very similar to the ridges on a common washboard. The same force which produces schistosity parallel to the axial plane of a fold will produce in slightly less plastic rocks fracture cleavage at an angle to the schistosity of the fold, so, if schistose rocks become hardened, fracture cleavage may be superimposed on schistosity. Such a false cleavage occurs in the Lovingson border fault on Route 29 at the entrance to Buckingham Circle, $\frac{1}{2}$ mile south of Charlottesville.

MULLION STRUCTURE

Mullion structures are large grooves which may be developed along a fault plane by rock movement. Such structures are well developed in a fault zone in the Lovingson gneiss on Route 29 at its intersection with Route 6. This outcrop is in Nelson County, $1\frac{1}{2}$ miles southwest of the Albemarle County line. The fault zone extends northward into Albemarle County.

NORMAL FAULT SHEAR ZONE

A shear zone composed of closely spaced normal faults, having a northwest-southeast strike, was exposed for a distance of approximately 1,800 feet in the cuts made for the extension of the Route 250 bypass around Charlottesville where it intersects Route 29 (Figure 16). The

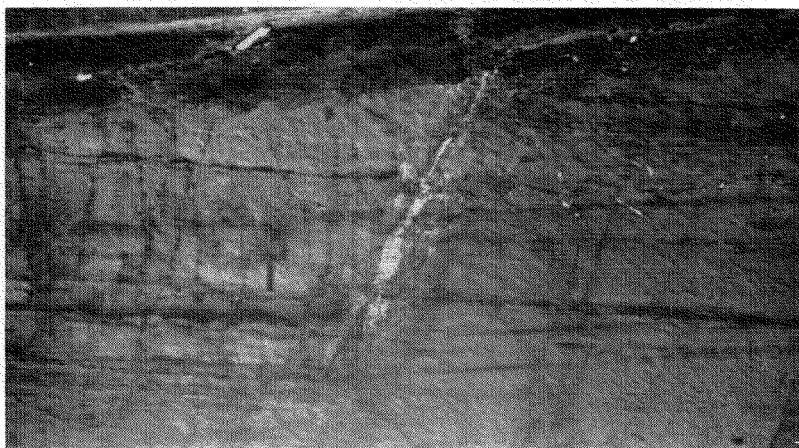


FIGURE 16. One of a series of faults in shear zone at intersection of U. S. Highway 29 and U. S. Highway 250 Bypass, Charlottesville.

normal faults vary from 5 feet to 100 feet from each other. Over ten of these faults were exposed. They make a shear zone which extends from this point through part of the gorge made by the Rivanna River where it cuts through Southwestern Mountain. The shearing of these rocks in this belt, 1,800 feet wide, is undoubtedly the reason for the Rivanna River cutting through the mountain at this point.

No measurements could be made on the horizontal or vertical displacement of these faults but the vertical displacement along some varved-like layers, which, it is thought matched each other, was of the magnitude of 5 feet. As there is no appreciable displacement along the contact line between the Catoctin and Swift Run formations the horizontal displacement is of small magnitude.

JOINTS

All of the rocks in Albemarle County exhibit more or less jointing. In the Catoctin greenstone relics of columnar joints of the original basalt forming part of this formation are found along the Chesapeake and Ohio Railway just west of Shadwell.

Joints due to crustal movements often intersect and occur from place to place in a distinct pattern. One hundred yards west of the Chesapeake and Ohio Railway underpass, on Highway 250, on the east side of the Blue Ridge Mountains, intersecting joints are well exposed in a Catoctin greenstone cut. The strike of some of these joints is as follows:

<i>Strike of Joint</i>	<i>Strike of Intersecting Joint</i>
S. 21° E.	N. 88° E.
*S. 49° E.	S. 29° W.
N. 10° E.	S. 65° E.
N. 18° W.	N. 89° W.
N. 24° E.	S. 40° E.
*S. 71° E.	N. 22° E.
N. 14° W.	S. 62° W.
N. 88° W.	S. 9° E.
*N. 54° W.	S. 88° W.
*N. 57° W.	S. 84° W.

Joints are well exposed in the Virginia Blue Ridge complex on secondary highway 689 on the south side of Yellow Mountain Creek, about one mile west of Yancey Mills.

<i>Strike of Joint</i>	<i>Strike of Intersecting Joint</i>
N. 20° W.	N. 60° E.
S. 52° W.	N. 70° E.
N. 20° E.	S. 70° E.
*N. 26° W.	N. 66° E.
N. 53° E.	S. 83° E.
*S. 52° W.	S. 18° E.
*N. 54° E.	N. 31° W.
N. 23° W.	S. 50° W.
N. 14° W.	N. 52° E.
S. 28° E.	N. 65° W.

The strike of joints were measured in the Lynchburg formation on the Barracks Road two hundred yards west of Highway 29:

<i>Strike of Joint</i>	<i>Strike of Intersecting Joint</i>
N. 84° E.	S. 44° E.
N. 28° E.	S. 64° E.
S. 40° W.	N. 84° W.

Joints are also well developed in the Triassic rocks on Highway 20 two miles north of Scottsville:

<i>Strike of Joint</i>	<i>Strike of Intersecting Joint</i>
S. 90° E.	N. 85° E.
N. 67° E.	S. 31° E.
S. 34° E.	S. 29° W.
N. 28° W.	N. 68° E.
N. 8° W.	N. 71° E.
S. 12° E.	S. 57° E.
N. 48° E.	N. 17° W.
N. 49° E.	N. 27° W.
N. 76° W.	N. 14° W.

From a study of these tables it can be seen that some of the joints observed in the Catoctin greenstone on the east slope of the Blue Ridge and some of the joints observed in the Virginia Blue Ridge complex near Yancey Mills are of Triassic age. Such joints are shown with an asterick in front of the compass direction.

The diabase dikes which occur throughout the county show well developed jointing where these dikes are exposed in highway or railroad cuts. It is, therefore, evident that all of the rocks in Albemarle County

have been subjected to Triassic stresses, which have strained the rocks to the point of producing a well defined joint pattern similar to the Triassic fault pattern.

A well defined joint pattern occurs in the large diabase dike which crosses Barracks Road just west of its junction with Highway 601. It is as follows:

<i>Strike of Joint</i>	<i>Strike of Intersecting Joint</i>
N. 32° E.	N. 61° W.
S. 78° W.	S. 30° E.
N. 59° W.	S. 31° E. most prominent
S. 40° W.	N. 62° W.
S. 55° E.	S. 44° W.
S. 35° W.	N. 86° W.

Joints play an important part in the amount of water produced from wells drilled in the Lovington gneiss, the Virginia Blue Ridge complex and the Catoctin greenstone.

GEOLOGIC HISTORY

The pre-Cambrian basement complex formation in Albemarle County is a quartz monzonite gneiss, commonly called the Lovington gneiss. Before metamorphism this gneiss may have been formed from plutonic rocks, or may be a paragneiss (Mertie, 1956) and originally derived from pre-Cambrian sediments. These rocks occur at the base of a column of pre-Cambrian sediments and lava flows over 60,000 feet thick which formed a great geosyncline east of the present Blue Ridge Mountains.

The Lovington gneiss was base leveled and submerged and covered by a boulder conglomerate composed of rounded and flattened boulders of Lovington gneiss up to one foot in diameter which formed the basal 100 feet of the Rockfish conglomerate having a total thickness of 1,200 feet near the Albemarle-Nelson County line $1\frac{1}{4}$ miles northeast of Faber. Around Charlottesville the boulder conglomerate is 50 feet thick and the total thickness of the Rockfish conglomerate is 3,200 feet. The Rockfish conglomerate is well exposed on Highway 29 just southwest of Charlottesville. North of Charlottesville this formation is replaced by a granite injected into the Lovington formation along its southeastern edge. It occupies a belt 6,900 feet wide at the Albemarle-Greene County line.

Overlying the Rockfish conglomerate formation is the Lynchburg gneiss (restricted) which occupies a belt 5,000 feet wide along the Albemarle-Nelson County line. In the Charlottesville area this formation is so badly faulted that it is impossible to measure its true thickness. North of Charlottesville it underlies a belt 7,500 feet wide along the South Fork of the Rivanna River. Along the north side of the North Fork of the Rivanna River this same belt is 9,900 feet wide. On the Greene County line the belt has increased and has a width of 12,000 feet.

As this formation occupies a belt in which folding and faulting is prevalent, no true thickness of the Lynchburg formation (restricted) can be given, but from the above facts it is logical to assume that this formation thickens from the southwest edge of the county to the county's northeast edge.

The Johnson Mill formation was deposited on the base leveled, eroded top of the Lynchburg formation (restricted). It is 300 feet thick at its type locality and thickens slightly to the north, being 500 feet thick near Profit. It has this approximate thickness northeastward to the county line.

Overlying the Johnson Mill formation is the Charlottesville formation, which is 4,300 feet thick at its type locality. It underlies a belt south of

Charlottesville, east of Powell Corner, which is 5,700 feet wide. On the Nelson County line this same belt is 12,000 feet wide, undoubtedly due to faulting and repetition of beds in this area. To the north of Charlottesville this formation in the vicinity of Gilbert occupies a belt 5,500 feet wide.

Overlying the Charlottesville formation is the Swift Run formation, which has a thickness of 1,200 feet on the Nelson-Albemarle County line, while at Powell Corner it has a thickness of 3,000 feet. Its measured thickness in Charlottesville is 2,250 feet. North of Charlottesville to the county line it varies between 2,100 feet and 2,500 feet in thickness.

Overlying the Swift Run formation is the Catoctin greenstone. On the Albemarle-Nelson County line it is 5,000 feet thick. The belt occupied by the formation progressively widens until it is 31,000 feet on the Orange County line. A section through Monticello shows a width of 17,250 feet.

Overlying the Catoctin greenstone is the Loudoun (Unicoi) formation. On the west side of the Blue Ridge at Rockfish Gap, near the western edge of the county, the Unicoi formation is 3,220 feet thick. At Keswick, on the east side of Southwestern Mountain, this formation is 7,500 feet thick.

At Keswick this same formation, called the Loudoun formation in the Virginia Piedmont, has the lower part of the Rockfish Gap section missing. The upper part of this section lies unconformably on the top of the Catoctin. This has been interpreted as due to an eastwardly advancing shore line. But as the Loudoun formation at Keswick has a thickness of 7,500 feet the advancing shoreline hypothesis could be incorrect and the fact that only Upper Unicoi was deposited on top of the Catoctin might be due to the deposition of excessive thicknesses of the lava flows which make up the Catoctin, which flows were not submerged until Upper Loudoun Time. At that time about 7,500 feet of Loudoun sediments were laid down in the great geosyncline in this county east of the Blue Ridge.

The Loudoun (Unicoi) formation is really a Piedmont formation, which overlapped into the eastern edge of the Appalachian Valley. From Keswick to the northeast corner of the county the Loudoun formation occupies a belt varying from 7,000 to 5,400 feet wide. In the southern half of the county the Loudoun occupies a wide belt, 12,000 feet, or more, wide, due to repetition by faulting.

Overlying the Loudoun in eastern Albemarle County is the Everona limestone, now considered to be of upper-Cambrian age. It was formerly considered to be of Ordovician age. On Route 250 east of Charlottesville it is well exposed at Limestone Creek, occupying the axis of a synclinal

fold. Its true thickness at this location is approximately 1,000 feet. In the northeastern half of the county it can be mapped as a distinct limestone belt, but in the southeastern part, from the Rivanna River to the northeast edge of the Scottsville Triassic basin, it is lense-like or faulted. Several well developed lenses occur en echelon, or faulting is responsible for this pattern.

These figures show that along the northern edge of Albemarle County sediments and lava flows totaling approximately 60,000 feet were deposited on the Lovington gneiss, while along the southern part of the county approximately 36,000 feet of sediments and lava flows accumulated. Even if fifty percent of the above thicknesses are repetitions, due to folding and faulting, no such accumulation could take place unless a major geosyncline came into being so that by such a major downwarping this great thickness of sediments and lava flows could accumulate.

The downwarping in this geosynclinal area to the east of the Appalachian geosyncline started at the end of Archean time with the deposition of Rockfish formation sediments, followed by Lynchburg, Johnson Mill, Charlottesville, Swift Run sediments, Catoctin sediments and volcanics, Loudoun sediments and Everona limestone.

This geosyncline, filled with tens of thousands of feet of sediments and volcanics, was then uplifted first during the Taconic revolution (Ordovician) at which time there was a close relation between the dynamic forces causing this uplift, the granite invasions, cutting the Lovington and Virginia Blue Ridge complex, and the hydrothermal solutions which spread through the country rock, producing metamorphism. Woodward (1957) considers that the Taconic revolution was more extensive and vigorous than the Appalachian.

The uplift of the ancestral Blue Ridge Mountains at the close of Ordovician time is further indicated by the distinct change in the sedimentary rocks which were deposited in the Appalachian seaway just west of this mountain chain. The predominate limestone formations of the Ordovician are replaced by coarse sandstones and sandstone conglomerate totaling 1,400 feet (Nelson, 1940) (Brent, 1960) followed by the 5,650 feet of sandstones in Devonian time.

At the close of the Taconic revolution, the crest of the ancestral Blue Ridge Mountain in Albemarle County left the present Blue Ridge at Jarmans Gap and followed Buck Elbow to its northeastern end, then extended northward through Fox Mountain and back to the present

crest of the Blue Ridge Mountains through Flat Top Mountain in Greene County.

The last major folding was the Appalachian revolution (close of Paleozoic) which has put most of the final touches on the Alpine-like structures which are now found in Albemarle County.

The next major structural movements were during Triassic time when the faulted areas were produced in which Triassic sediments were deposited. Parts of two such Triassic basins occur in this county. On the northern boundary of the county less than $\frac{1}{4}$ mile of the Culpeper basin occurs in the county. In the southern part of the county a large part of the Scottsville basin extends from the Hardware River to Howardsville.

These movements continued after the close of Triassic time as Triassic diabase dikes are offset by normal faults extending northeast and southwest.

The northern and central part of Albemarle County, between Southwestern Mountain and Mechum River, has been subject to faulting by these Triassic and post-Triassic faults, which have offset in numerous places, particularly around Charlottesville and Dawson Mill, both amphibolite, metapyroxenite, felsite and diabase dikes.

During Pleistocene time, faulting occurred in Albemarle County. Such faulting occurs on Route 250 between Lebanon Church and the foot of the Blue Ridge Mountains, which is a shear zone area in which numerous high angle thrust faults occur (Figure 15). The one exposed at Lebanon Church has a strike of N. 20° E., and a dip of 57° to the southeast. It displaces a terrace gravel deposit five feet, and some of the gravel is dragged into the fault plane. This terrace gravel is 60 feet above Stockton Creek and is of Pleistocene age.

No earthquakes have been noted as originating in Albemarle County.

MINERAL DEPOSITS

AMETHYSTS

Amethysts were found several years ago by the author in rock blasted for planting peach trees. The orchard was located on the west side of Highway 795 between Simeon and Ash Lawn. The quartz veins occurred in a coarse quartzitic sandstone next to greenstone.

Location No. 1.

ASBESTOS

Asbestos has been found in thin, platy masses in a soapstone dike occurring near Alberene. It is of the amphibolite variety (Watson, 1907).

BARITE

An outcrop of barite in a quartz vein was discovered by members of the class in mineralogy at the University in 1959. The outcrop is less than a foot wide and occurs 100 yards south of Highway 250 on the east slope of a hill leading down to an unnamed creek one mile west of Shadwell.

Location No. 2.

BRICK

In 1817 Thomas Jefferson obtained brick makers, and brick layers from Lynchburg, where it was stated a new method of molding brick in oil was being used. The clay used in making the brick for the original University of Virginia buildings was obtained from University property (Bruce, 1920). It was burned by Perry, Thorn, Carter and Phillip, and Nathaniel Chamberlain. These brick were used in building the pavilions and the serpentine walls, and later the Rotunda at the University of Virginia.

Brick have been made in the past at a number of places. The Monticello Brick Company operated in Charlottesville on 7½ Street S.W., near Cherry Avenue until 1944, using clay formed by the weathering of the Charlottesville formation. They had five kilns and made a regular sand finished brick, as well as a special old hand made brick.

BRICK CLAYS

Tests were made on the residual clays in this county near Keswick and Crozet by H. Ries and R. E. Somers (1917). The following statements are summarized from their report:

A dark brown sandy clay, with good plasticity (Lab. No. 2085) occurs about one-fourth of a mile southwest of Keswick. The addition of 30

percent of water gave a workable mass whose average air shrinkage was 5.6 percent and at Cone 05 it gave a good brick. Fire shrinkage and absorption at Cone 0/0 were 1.3 and 24.4 percent respectively, while at Cone 05 they were 2.3 and 19.7 percent.

Just north of Brownsville a yellowish-brown clay occurs, with scattered rock fragments (Lab. No. 2078) is of fair plasticity and worked up with 33 percent water to a mass whose air shrinkage was 5.4 percent and average tensile strength 59 pounds per square inch. The clay burns red, is steel hard at Cone 03, but has a fair ring at Cone 010. This clay should make a good common brick by the soft-mud process and could probably be worked in the stiff-mud machine.

A little farther north residual clay outcrops again (Lab. No. 2076). This is a brown plastic, smooth clay which burns red and has a low air shrinkage. It should be burned in Cone 05 for good results.

Along the road up to half a mile north of Crozet Station there are several cuts showing very consistent and homogenous clay, and one sample (Lab. No. 2055), one-fourth of a mile north of the railroad is quite typical. This red brown clay has good plasticity. With 31 percent water it developed a workable body for soft-mud molding. The air shrinkage is 5.2 percent but the average tensile strength is not over 15 pounds per square inch. It burns to a red bricklet, steel hard, at Cone 03, but not sound enough unless fired in Cone 05.

This material can be used for making common brick if properly fired.

Red Triassic shale, occurring in the Scottsville Triassic area in the southern part of the county, has been used in the making of brick in adjacent counties to the north. Although no detailed tests have been made of this Triassic shale it is undoubtedly suitable for the making of brick.

BUILDING STONES

Sandstone layers in the Rockfish conglomerate were quarried on Observatory Mountain, part of the University of Virginia grounds, and used in the original buildings of the University as steps and sills.

A brownstone quarry was opened in 1885 at Midway Mills on the Chesapeake and Ohio Railway near Howardsville in Nelson County. This brownstone was used in buildings from Lynchburg to Abingdon according to Hotchkiss (1885). The quarry was abandoned many years ago.

Felsite building stones were used in constructing a stone house built after 1925 in Charlottesville at the corner of Valley Road and Jefferson Park Avenue.

STONY POINT COPPER MINE

This abandoned mine is located just west of the base of Southwestern Mountain on Priddy Creek, a small branch of the north fork of the Rivanna River, about 1½ miles northeast of Stony Point on Highway 640, about two hundred yards northwest of its Junction with Highway 20. Location No. 3.

This property was first worked in 1885 by Major Mason, who bought it in 1878 (Watson, 1901). The incline shaft is reported to have reached a depth of 130 feet. It was reported that 2,500 carloads of gossan iron ore were shipped.

This copper vein is a fissure type vein, which was test pitted for a distance of 1,800 feet. On its outcrop it averages about 5 feet in thickness. It is faulted at its northeast end by post mineral faulting, the fault zone containing a felsite dike. A geophysical survey of this vein was made by Tazelaar (1958) using the self potential method. The major minerals in this vein are pyrite, siderite and some chalcopyrite, the siderite replacing the sulphide ores.

This mineral deposit was also reported on by Newhouse (1933). It was first mentioned by Rogers (1884) in his *Geology of the Virginias*.

This property was diamond drilled by the American Metals Company in 1936 and was not considered attractive enough to operate.

CRUSHED STONE

There are three commercial crushed stone quarries located in this county.

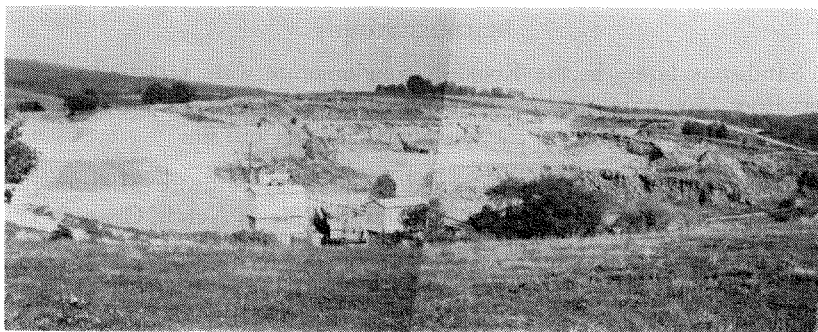


FIGURE 17. Charlottesville Stone Company's quarry in the Catoctin formation near Shadwell.

The Charlottesville Stone Company is located on the south side of Highway 250, about one mile west of Shadwell (Figure 17). This quarry is located in the Catoctin greenstone, where it shows very little schistosity. The company's headquarters are in Richmond, Virginia.
Location No. 4.

About one mile east of Red Hill, on Secondary Highway 708 and on a spur of the Southern Railway, there is located, on the south end of Dudley Mountain, the largest crushed stone quarry in the county (Figure 18). It was opened in 1955 by the Superior Stone Company, (North Garden) a division of the American-Marietta Company. Dudley Mountain is composed entirely of Lovingsston gneiss. At its southern end, where the quarry is located, the gneiss is rather massive and has little gneissic structure.

Location No. 5.

FLUORSPAR

Fluorspar was found in the lead zinc mine near Faber. The purple fluorspar is a prominent gangue mineral.

Location No. 6.

GARNETS

Garnets occur in many places in the Lovingsston gneiss. They have especially been noted on Highway 637 between Ivy and Batesville.

GOLD

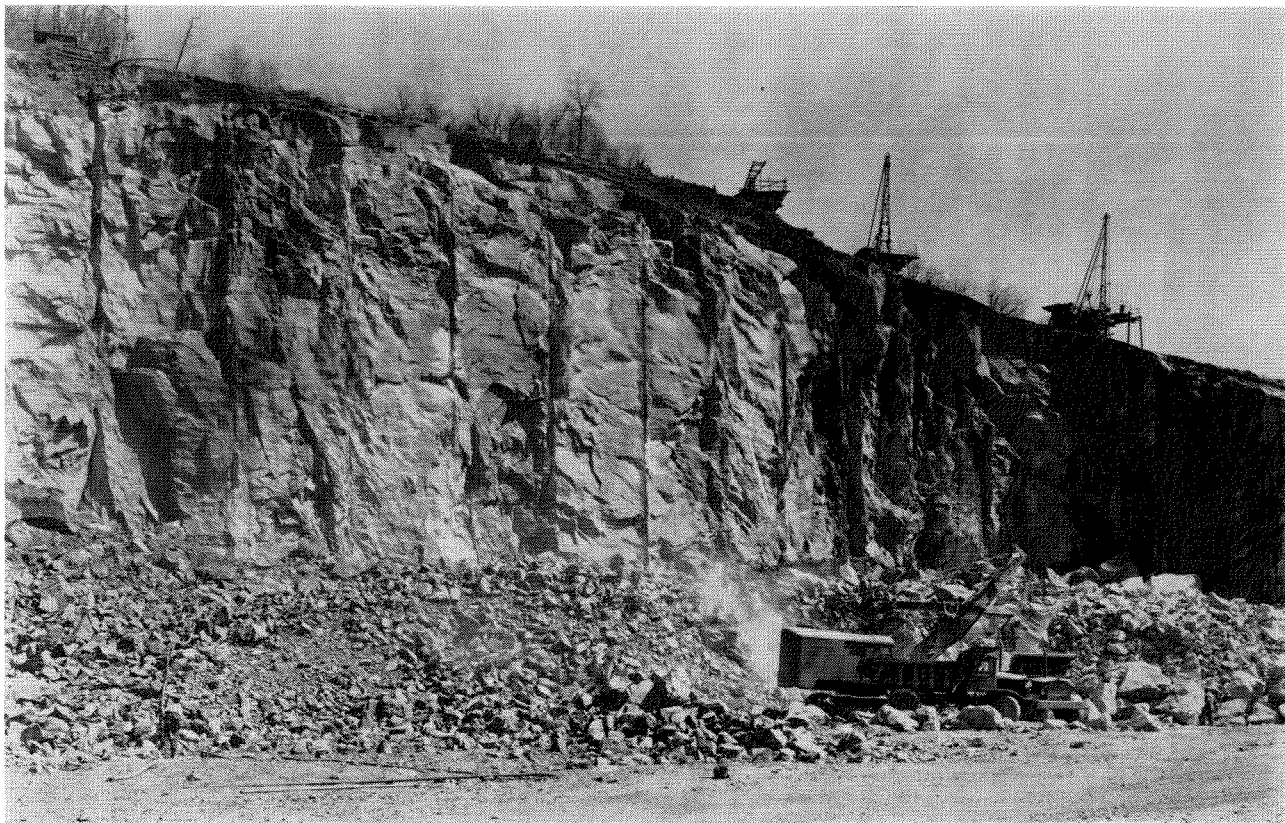
Gold "streaks" have been obtained from panning selected specimens of quartz from veins in the slate belt east of Southwestern Mountain (Lambeth, 1901).

GRAPHITE DEPOSITS

An abandoned graphite mine occurs on the headwaters of Piney Creek at the southeast foot of Naylor Mountain, $\frac{1}{2}$ mile to the northwest of Highway 671 (Anonymous, 1906).

At the abandoned shaft a few flakes of crystalline graphite were found. The shaft is in a shear zone in the Virginia Blue Ridge complex, less than 100 feet from a nearby diabase dike which is about 175 feet wide.

No information is available on the work done at this mine.
Location No. 7.



Courtesy of American Marietta Co.

FIGURE 18. Superior Stone Company's quarry, Red Hill, Virginia.

IRON ORES

COOK MOUNTAIN MAGNETITE DEPOSITS

The first mining of iron ore in Albemarle County was done before the Revolutionary War just east of North Garden on the northeast side of Cook Mountain by the people who operated Olds iron furnace a short distance from this mine. The old open cuts from which the ore was mined are now overgrown and partially filled by debris. The ore deposit consists of several lenses of magnetic iron ore occurring in the Lovingston gneiss.

The size of these cuts indicates that sufficient iron ore was mined to furnish the Olds furnace with the ore needed for this operation. Thomas Jefferson (1787) mentions Olds iron works as one of the chief iron works in Virginia.

Watson, in the Mineral Resources of Virginia, gives an analysis of this ore as made for the Tenth Census report as follows: "Metallic iron 46.69, phosphorous 0.055."

The class in geophysics of the University of Virginia, under the direction of Robert S. Young, made a magnetic survey of this property. The following statement has been furnished by Dr. Young:

"Magnetic surveying completed during March, 1960. A survey grid covering 22 acres was laid out centering on the northwest end of the major pit. The grid is 1,200 feet long and 800 feet wide, with the base line oriented N. 15° E. Along the base line traverses were made at every 200 feet. Magnetic readings were taken on the traverses and along the base line at 25 foot intervals.

"Magnetic data were taken with a Sharpe Model A-2 Vertical Intensity Magnetometer. The operating range of this instrument is $\pm 15,000 \gamma$, with a direct reading sensitivity of 2γ .

"A relatively small but high-value magnetic anomaly is present to the west and south of the major pit. Peak values of the anomaly were obtained on grid stations $0 + .5E (+ 2052\gamma)$ and $2S + 2.5E (- 4360\gamma)$, which gave a total magnetic relief of 6412γ .

"Magnetic float was observed on the steep hill slope 500 to 600 feet west of the old pit. Exploration should be extended in this direction." Location No. 8.

LIMONITE DEPOSITS

In mapping the geology of this county the author found outcrops of limonite at several places. One is about one mile northeast of Cobham

on the southwest side of Mechum Creek.

Location No. 9.

Another outcrop was found a few hundred yards from Lindsey's Station.

Location No. 10.

A third outcrop occurs about $1\frac{1}{2}$ miles northeast of the Woodbridge School.

Location No. 11.

Gossan float was found on Highway 600 at a distance of $\frac{3}{10}$ to $\frac{4}{10}$ of a mile from Route 20 near Stony Point.

Location No. 12.

SPECULAR HEMATITE

Specular hematite occurs in one old pit about 500 yards north of Highway 641, extending from Route 20 to Burnleys. Local residents state that some ore was mined at this pit over eighty years ago. The deposit is in the Swift Run formation, a short distance from the southwestern corner of the Barboursville Triassic basin.

Location No. 13.

STONY POINT MINE

This mine has been discussed under copper as it is a copper iron vein, although the only ore shipped from this mine was gossan iron ore. Between 1878 and 1885 it is reported that 2,500 carloads of iron ore were shipped to Pittsburgh (Watson, 1907).

Location No. 3.

LIMESTONE QUARRIES

Numerous quarries have been developed on the Everona limestone belt, occurring to the southeast of Southwestern and Carter Mountains.

Shortly after Albemarle County was settled limestone quarries were opened from which lime was obtained by burning, for use in the construction of many of the houses and buildings in this area, and also for agricultural use. The lime used in constructing the buildings at the University of Virginia was made from limestone quarried near Campbell on the Bolling farm west of Campbell on the southwest side of Route 600 and on the north side of Mechum Creek.

Location No. 15.

The Farm and Home Lime Quarry is located on a bluff on the north bank of the Hardware River on Mt. Pleasant Farm. This quarry was first

operated by J. D. Moon (Rogers, 1884) from 1840 to 1860 to produce agricultural lime. It was reopened in 1929 by Mr. Simmons and was operated for five years. The product was ground agricultural lime.
Location No. 16.

The Bishop Quarry is a short distance from Route 620. It was opened by Charles Bishop before the Civil War to make lime used at Charlottesville and Scottsville.
Location No. 17.

There is an abandoned quarry on the farm of Mr. Hensley off Route 728. It was operated from 1820 to 1840 to make lime.
Location No. 18.

The Garland limestone quarry on Route 53 near Buck Island Creek, was mentioned by Rogers (1838). It was abandoned after the Civil War, but many years later it was reopened thirty yards west of the original location. In 1947 and 1948 aggregate for road construction was quarried. The exposed limestone has a thickness of 138 feet.
Location No. 19.

The Superior Stone Company Quarry was opened in 1950 east of Route 231 in Louisa County about $\frac{1}{2}$ mile from the Albemarle County line. After five years it was closed down but has been recently reopened. The exposed limestone has a thickness of 1,100 feet and a dip of 68° to the southeast.
Location No. 20.

Some of the above quarries were described by Mack (1957).

PYRITE MINE

In December, 1917, the Ohio Sulphur Mining Company, of Columbus, Ohio, leased several tracts of land about a mile northwest of Proffit in the Johnson Mill graphite slate formation to mine the pyrite occurring in this slate. The shaft is stated to have been dug to a depth of 150 feet and some development work was carried on from the shaft. Royalties to be paid were listed in the lease as follows: (County Court Clerk's office).

"16c per ton of graphite

"15c per ton of sulphur

"15c per ton of pyrite

" $\frac{1}{2}$ of net product of diamonds

" $\frac{1}{2}$ of net product of gold"

After approximately one year's operation the company abandoned the property.

Samples of black slate around the old shaft show pyrite veinlets and crystals scattered through the slate but no indication of a definite vein. It is definitely a Faldband type of deposit.

Location No. 21.

A geophysical survey was made at this old mine by the class in geophysics at the University of Virginia in 1959, under the direction of Robert S. Young. A map of this survey, accompanied by detailed explanations, was furnished by Dr. Young for inclusion in this report.

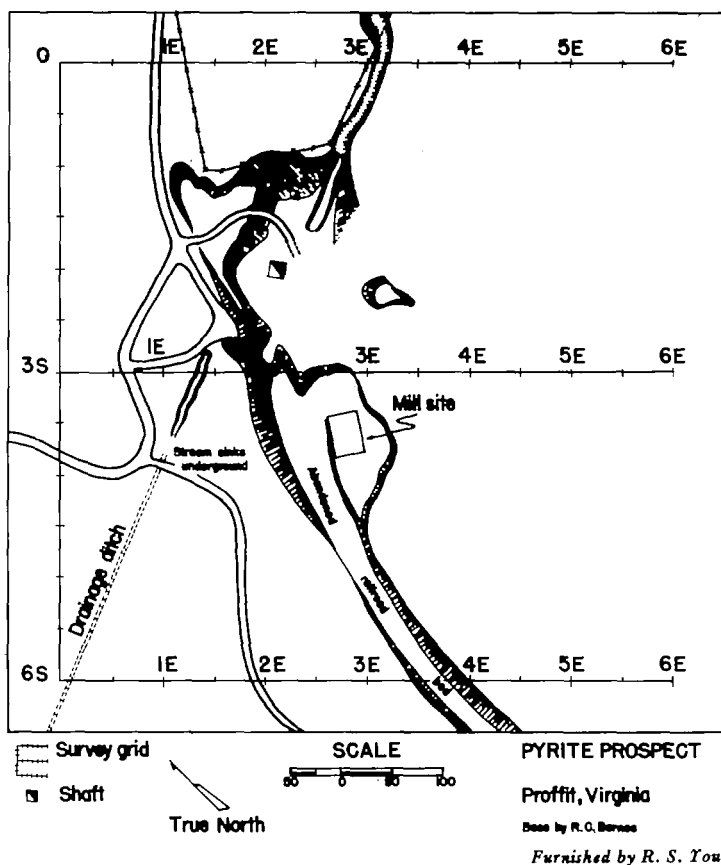


FIGURE 19. Location of self-potential and magnetic profiles adjacent to Ohio Sulfur Mining Company's mine, near Proffit.

In May, 1960, reconnaissance SP and magnetic traverses were run on the Ohio Sulphur Mining Company's abandoned mine near Proffit. A small grid was laid out 600 feet long and 600 feet wide, with a base line direction of N. 45° E.

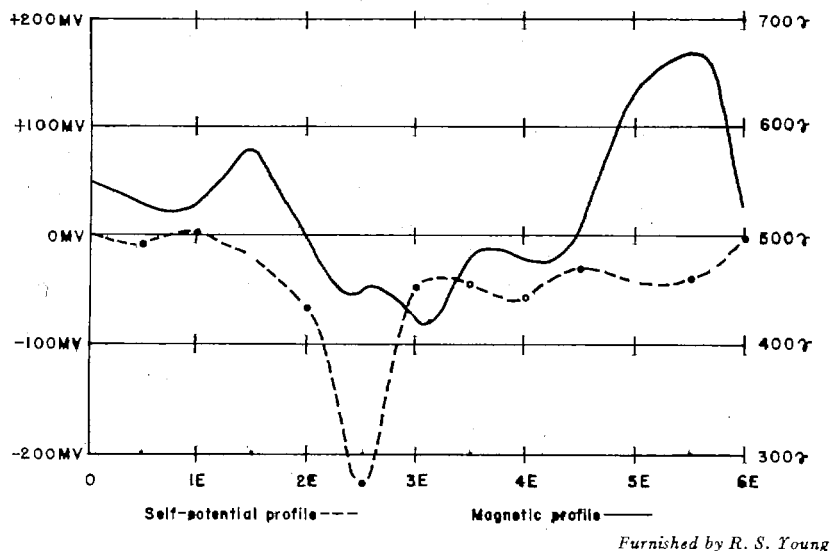


FIGURE 20. Profiles of Traverse O, S. 45°E.

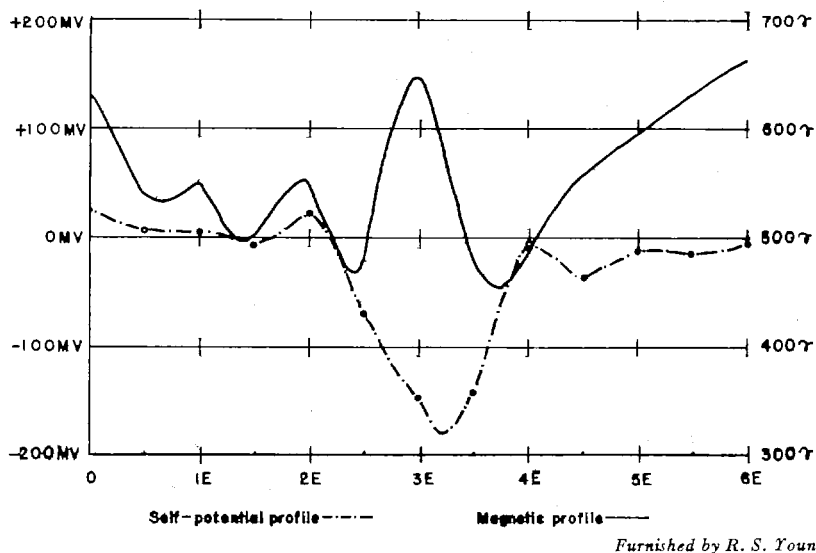
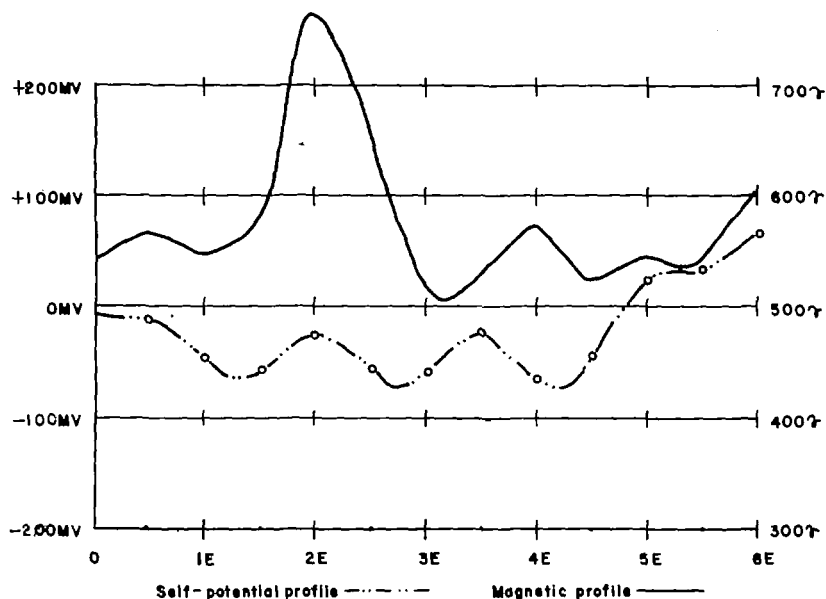


FIGURE 21. Profiles of Traverse 3S, S. 45°E.

The SP data, with all readings referenced to Station 0+0 as *zero*, are presented in the form of related profiles. Potential anomalies are well-defined on traverses "0" and "3S", in the range of 200-300 millivolts. These potential departures may be the reflection of either iron sulfides or graphite, or both. As the iron sulphides occur in a graphitic schist (appear to be restricted to it), the SP method is an excellent one with which to outline the zone.

To provide supplementary information, a magnetometer survey was completed on the same grid. The magnetometer used was a Schmidt balance instrument which measured vertical intensity. Small anomalies were recorded on each traverse line, with spectacular confirmation of the SP peak on Line "3S". The magnetic departures are in the range of 200 gammas.

The confirmation of the SP anomaly on "3S" by magnetic data indicates the probability that the iron sulfide is in large part pyrrhotite.



Furnished by R. S. Young

FIGURE 22. Profiles of Traverse 6S, S. 45° E.

SAND

Washed sand is produced by three companies: Charlottesville Sand & Gravel Company, 4 miles north of Charlottesville on State Road 643; the Hydraulic Company, at Hydraulic near State Road 743; and S. L. Williamson Company, Inc., at the eastern edge of Charlottesville. Locations No. 22a, b, c.

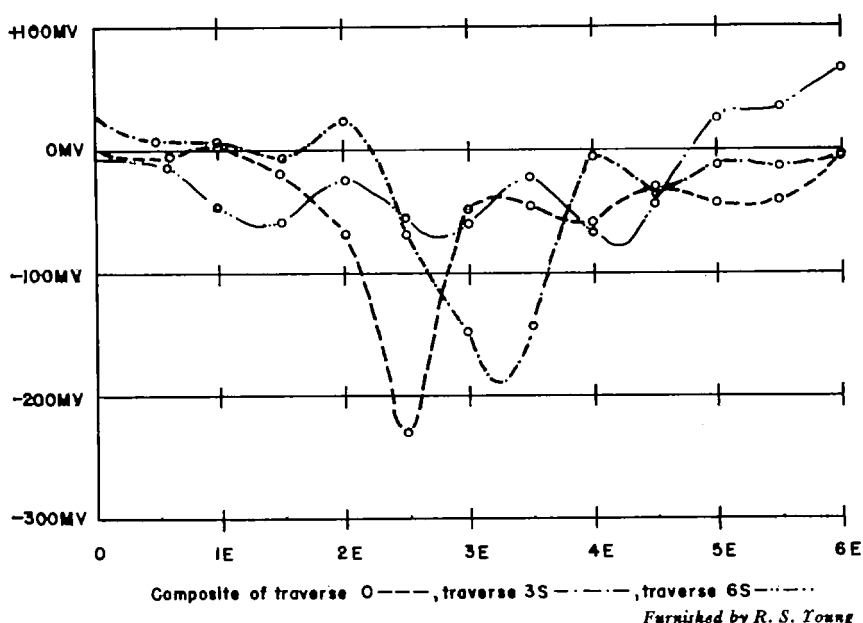


FIGURE 23. Related self-potential profiles over abandoned pyrite mine near Proffit.

SLATE DEPOSITS

The slate belt in this county parallels the belt of Everona limestone and lies on both sides of this belt. The slate occurs in the Loudoun formation.

In the past roofing slates were quarried at Forest Hill just south of the University of Virginia airport. Slate pencils were made at the Cox quarry just south of Forest Hill. Location No. 14. This slate belt crosses the Chesapeake and Ohio Railway about one-half mile west of the Keswick depot.

Another old slate quarry was south of the junction of the old road from Shadwell to Keswick and the road to Limestone Creek (Lambeth, 1901). Today Highway 250 practically parallels this old road.

ESMONT SLATE QUARRY

During 1906, the Blue Ridge Slate Corporation opened a quarry at Esmont to produce slate granules for roofing shingles (Dale 1913-1914). This quarry was operated until 1929 when, due to a slide, operations were stopped for three years. From 1932 to 1957 slate granules were produced

at this quarry and artificially colored. The quarry was abandoned in 1957. Location No. 23.

SOAPSTONE AND SERPENTINE

The largest soapstone quarries in the United States are along the Albemarle-Nelson County line and are located in both counties.

The soapstone belt in Albemarle County lies just west of Green Mountain.

The soapstone dikes vary from approximately 160 feet to less than 100 feet in width. There are several of these dikes which roughly parallel each other, dip at an angle of approximately 60° to the southeast and extend northward to the vicinity of Alberene. North of this point the dikes are not wide enough, or of the proper quality, to be worked commercially.

These dikes are metapyroxenite dikes, which have been hydrothermally altered in places to produce the so-called commercial soapstone deposits. The products from these quarries are now sold as serpentine and soapstone.

In 1926 David Ives Bushnell was shown some old soapstone pits just south of Damon in the southern part of the county. His examination of these pits showed that they extended for a distance of 1,000 feet along a high ridge just south of Damon. His archeological work at this point showed that there were more than twenty excavations, ten to thirty feet in diameter and, at that time, from two to four feet deep. They were partially filled with debris. Many broken vessels were found in the debris, which were oval in form with knobs extending from both narrow ends. They were bowls broken in the process of carving. Quartz implements were used in making these bowls. It is not known whether the Monacan group of Indians, belonging to the Siouan tribe, made these bowls or whether they were made by an earlier tribe of Indians who inhabited this section. Location No. 24.

The Alberene Soapstone Division of the Georgia Marble Company operates two quarries in this county; one a short distance from Schuyler (Location No. 25) which quarries serpentine, Figure 24, and one near Alberene (Location No. 26) which quarries a hard soapstone. Quarries producing standard soapstone are located near Schuyler in Nelson County. No standard soapstone is quarried in Albemarle County at the present time.

A report made by the author, in 1932, to the Alberene Soapstone Company showed that much of the rock they were quarrying was primarily

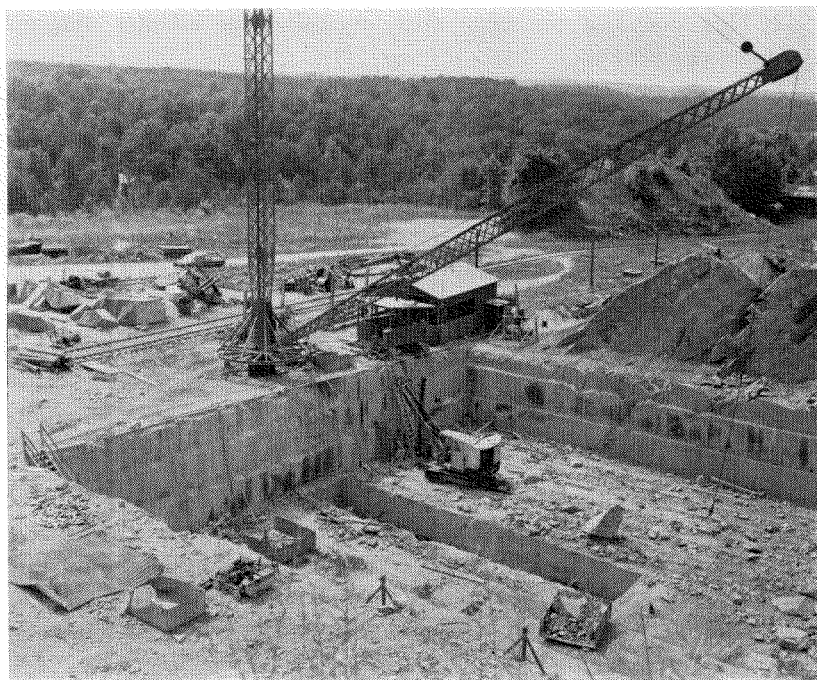


FIGURE 24. Serpentine quarry of Alberene Stone Division of the Georgia Marble Company.

composed of the mineral serpentine, which rock, at that time, was being sold as hard soapstone.

The hydrothermally altered dikes are composed primarily of the following minerals: Serpentine, tremolite, chlorite, talc and small amounts of calcite and magnetite. Where talc and chlorite predominate, the quarried rock is sold as soapstone; where serpentine and tremolite predominate the rock is sold as serpentine. The serpentine is used for interior decoration, while the soapstone is made into acid proof sinks, acid proof table tops, electric switchboards and insulators, and for many other purposes where an acid resistant rock is needed. The waste material from some of the quarries is pulverized and used as a filler, or as a lubricant.

The first year for which statistics on the production of soapstone are available is the year 1898 when 10,050 short tons were produced.

In 1929, Burfoot described in detail the talc and soapstone deposits of Virginia, with special emphasis on the deposits in Albemarle County. In

1932, Hess described the same area, discussing the asbestos, talc and soapstone deposits.

ZINC AND LEAD DEPOSITS

One deposit of zinc and lead ores has been mined in the past. This mine was opened by the Albemarle Zinc and Lead Company about 1906. It is located approximately two miles slightly north of east of Faber, a station on the Southern Railway just east of the Albemarle County line in Nelson County.

As the mine has been abandoned for many years, and, at the present time, is full of water and the shafts are partially caved, most of the information available is contained in Watson's Report on the Mineral Resources of Virginia, summarized as follows:

The main developments comprise three shafts sunk respectively to depths of 25 feet, 50 feet and 120 feet, and separated by a distance of about 1,000 feet between the two extremes. In addition to the three shafts the adit level has been run into the ridge from the valley bottom, and a cross-cut run from the adit on and along the vein for a distance of 140 feet.

The rocks in which the lead and zinc ores occur are metamorphosed crystalline schists of the Lynchburg formation, cut by a series of basic igneous rocks of the diorite and diabase types. The metalliferous vein is traced for a distance of several miles. It is of variable width, with an average of 4 feet; the strike is N. 45° E., paralleling the diorite dike 25 feet distant, on the northwest side; and it dips from 80° to 85° northwest. Where opened the vein is of the lenticular type, composed of bulbous bodies of fluorspar mixed with some quartz, through which the ore, blende and galena is distributed.

The ore, consisting of blende and galena, occurs chiefly in the fluorspar lenses, although the schist next to the lenses is often more or less mineralized. Figure 97, a drawing of a large mass of the ore-bearing fluorspar-quartz broken from one of the lenses, illustrates the typical occurrence of the ore. Some chalcOPYrite and smithsonite occur in addition to the principal minerals, blende and galena. Cerussite and azurite were reported some years ago from the dumps. The galena is argentiferous and arsenic and antimony are reported in very small quantities. Fluorspar is the principal gangue mineral.

In 1926, the author was able to enter the adit of this mine. At the southwest end of the adit the ore vein had a width of 12 inches and con-

sisted of a mixture of galena, sphalerite, fluorspar and quartz, with a schistose layer of rocks on each side of the vein showing movement. The vein occurs in the Lynchburg gneiss.

In 1959, Giannini reported on diamond drilling done at this abandoned mine and made a geochemical survey of the region. He considers the vein to be a hydrothermal replacement type deposit. At this time the property was owned by the R. S. Burruss Lumber Company of Lynchburg, Virginia.

Location No. 6.

On top of Fan Mountain, on the southeast side of an abandoned road along the crest of this mountain, 3.2 miles southwest of Johnson Mill, some prospecting has been done in a quartz vein which shows small amounts of lead and zinc ores.

Location No. 27.

GROUND WATER

Most of the water yield from the rocks of Albemarle County occurs in the many joints and fractures produced in these rocks by stresses, as the rocks themselves are essentially impervious. Most of the water bearing fractures are within 100 feet of the surface and there is very little chance of increasing the flow of a well below a depth of 300 feet. This does not seem to be true in the Crozet area where wells were drilled in the infolded Swift Run formation.

Precipitation in this county averages $44\frac{1}{2}$ inches per year. It is estimated that one-third of this soaks into the ground. The minimum safe yield for a home well is considered to be approximately 2 to 3 gallons a minute if a storage tank of 40 to 60 gallons is used, while a well producing less than one gallon a minute is considered a dry well.

Topographic and geologic locations should be considered in locating a well, as these are important factors affecting the capacity of a well in this county.

From a geological standpoint shear zones and contacts between different types of formations are the best localities for well locations.

From the standpoint of topography the well can be located on a hill, ridge, flat, slope or draw. A draw is considered to be a small valley and valleys are included under this term. From a topographic standpoint the best wells are located on flats, or in valleys.

BLUE RIDGE PHYSIOGRAPHIC PROVINCE

In the Blue Ridge physiographic province in this county there are many springs and most of the homes in this area fill their water needs from one or more springs.

PIEDMONT PHYSIOGRAPHIC PROVINCE

VIRGINIA BLUE RIDGE COMPLEX

The water bearing properties of the area underlain by the Virginia Blue Ridge complex are due to the number and size of the joints or fractures in this rock type. Wells generally only produce a few gallons of water per minute.

VIRGINIA BLUE RIDGE COMPLEX WITH INFOLDED SWIFT RUN

The Swift Run formation is infolded into the Virginia Blue Ridge

complex in a number of places between the Blue Ridge Mountains and the Mechum River graben. These infolds produce excellent water wells.

A number of wells drilled around Crozet in such an infold had yields of 12, 20, 75 and 100 gallons per minute.

The other infolded areas of the Swift Run formation should likewise produce excellent water. Several infolded areas occur in the northern part of the county, one between Free Union and the South Fork of the Rivanna River, another between Free Union and the Free Union School. An infolded belt extends from Pigeon Top Mountain northeastward to Boonesville.

MECHUM RIVER SLATE BELT

A few wells have been drilled in the Mechum River slate belt. Where the rocks are faulted and fractured the wells average from eight to fifteen gallons per minute.

LOVINGSTON GNEISS

Wells drilled into the Lovington gneiss are often dry wells or average only a few gallons per minute.

ROCKFISH CONGLOMERATE FORMATION

The Rockfish conglomerate formation produces a much higher yield of water per well than the wells from any other formation with the exception of the infolded Swift Run sediments around Crozet. The Rockfish conglomerate formation on the Barracks Road, just northwest of Charlottesville, has had a number of wells drilled in the different subdivisions which average from 25 to 30 gallons of water per minute.

LYNCHBURG FORMATION

The Lynchburg formation, which is a very fine grained, silty rock, has a much lower water yield than the Rockfish conglomerate. Again the yield is only several gallons per minute.

JOHNSON MILL FORMATION

The Johnson Mill graphite slate belt is so full of pyrite that no palatable water could be produced from wells drilled in this slate belt.

CHARLOTTESVILLE FORMATION

The Charlottesville formation is composed of the same type of fine grained sediments which make up part of the Lynchburg formation. The

yield from wells drilled into this formation would be only a few gallons per minute.

SWIFT RUN FORMATION, EASTERN BELT

Wells drilled into the eastern belt of the Swift Run formation produce excellent yields of water if drilled into the lower 600 feet of coarse quartzitic sandstones, or if drilled through the contact between the Swift Run and the overlying Catoctin greenstone.

The largest producing well in the county was drilled in the Key West subdivision, on the northeast edge of Charlottesville and attained its large flow of water at the contact of the Swift Run and the Catoctin. "Two water wells were drilled in this subdivision that provide a study regarding the productivity of two rock formations and the selection of drilling sites. In July, 1959, the first well was drilled 409 feet deep in a granite schist and was tested at the rate of $1\frac{1}{2}$ gallons per minute. In August, 1959, another well, located 200 yards north and 50 yards east of the first well, was drilled 263 feet deep in the Catoctin greenstone. Between 257 and 263 feet, two water-filled openings were penetrated in a sheer zone that may represent the contact between the Catoctin and the underlying formation. The well was pump tested for several hours at the rate of 200 gallons per minute, and continuously, for several days with a constant yield of 137 gallons per minute. This is the largest yield on record for any single well in Albemarle County. The first analysis indicated the water was very hard, had an abnormally high concentration of sulphur, and contained iron in excess of the normal acceptable limits. However, extensive pump tests were successful in reducing these objectionable conditions to within the acceptable limits prescribed by the Health Department." (Letter from Virginia Division of Mineral Resources, 1961)

CATOCTIN GREENSTONE

The Catoctin greenstone, composed of metamorphosed, basaltic lava flows with interbedded metamorphosed sediments, is a very dense rock and produces very low yields of water. Most of the wells produce only a few gallons of water per minute. The numerous estates, located on the east side of Southwestern Mountain in the Catoctin greenstone belt, receive their water from the many springs located on the side of Southwestern Mountain.

LOUDOUN FORMATION

The Loudoun formation occupies a wide belt in this county between Southwestern Mountain and the Fluvanna County line. A number of

wells have been drilled in this formation around Keswick, at the University airport and at country homes throughout this area. Ten such wells scattered through the area produce from 3 to 7 gallons per minute.

EVERONA LIMESTONE FORMATION

The Everona limestone formation roughly parallels the Chesapeake and Ohio Railway north of Keswick. It appears that only two wells have been drilled in this formation, one having a yield of $6\frac{1}{2}$ gallons per minute, and the other of $7\frac{1}{2}$ gallons per minute.

TRIASSIC AREA

In the large Triassic area between Glendower and Scottsville, and extending from the Hardware River to the James River, a number of wells have been drilled. Five wells show yields of from 5 to 20 gallons per minute. The average yield is about 7 gallons per minute, although one well produced only $1\frac{1}{3}$ gallons of water per minute. A well properly located in the Triassic area should at least yield from 5 to 9 gallons per minute.

DIABASE AND AMPHIBOLITE DIKES

There are numerous diabase and amphibolite dikes in the county, ranging from 100 to 2,100 feet in width. These igneous rocks are very dense and, if possible, wells should only be drilled at their contact with the adjacent metamorphic rocks where numerous joints and fractures generally exist.

REFERENCES

- ANONYMOUS, 1906, The Naylor-Bruce graphite Company of Charlottesville: Eng. & Min. Jour., vol. 81.
- BLOOMER, R. O., 1950, Late Precambrian or Lower Cambrian formations in central Virginia: Am. Jour. Sci., vol. 248, no. 11, pp. 753-783.
- , and BLOOMER, R. R., 1947, The Catoctin formation in central Virginia: Jour. Geol., vol. 55, no. 2, pp. 94-106.
- , and WERNER, H. J., 1955, Geology of the Blue Ridge region in central Virginia: Geol. Soc. America Bull., vol. 66, pp. 579-606.
- BRADLEY, F. H., 1874, On unakite and epidotic rocks from the Unaka range (Tenn): Amer. Jour. Sci., vol. 7, p. 519.
- BRENT, WILLIAM B., 1960, Geology and Mineral Resources of Rockingham County: Bulletin 76, Virginia Division of Mineral Resources. 174 pp.
- BROWN, W. R., 1958, Geology and mineral resources of the Lynchburg quadrangle, Virginia: Virginia Division of Mineral Resources, Bull. 74, 99 pp.
- BRUCE, PHILIP ALEXANDER, 1920, The history of the University of Virginia: vol. I, the Macmillan Co.
- BURFOOT, J. D., JR., 1930, The origin of the talc and soapstone deposits of Virginia: Econ. Geol., vol. 25, no. 8, pp. 805-826.
- BUSHNELL, DAVID IVES, 1926, An ancient soapstone quarry in Albemarle County: Jour. Washington Acad. of Sci. vol. 16, No. 19.
- CAMPBELL, M. R., 1899, U. S. Geol. Survey Bristol Folio: no. 59.
- CORDOVA, R. M., 1955, The general geology-petrology of the greenstone of the Southwestern Mountains, Virginia: M.S. Thesis, University of Virginia
- COOKE, B. C., JR., 1952, The structure and petrography of the Rockfish conglomerate, Virginia: M.S. Thesis, University of Virginia.
- CROSS, WHITMAN II, 1960, Water-well data western part of Albemarle County: Division of Mineral Resources Information Circular 2.
- DALE, T. N., 1913, The commercial qualities of the slates of the United States and their localities: Mineral Resources. U. S. Geol. Survey.
- , 1914, Slate in the United States: U. S. Geol. Survey Bull. 586.
- DARTON, N. H., 1891, Mesozoic and Cenozoic formations of eastern Virginia and Maryland. Geol. Soc. America, Bull. vol. 2, pp. 431-450.
- DEVEREUX, R. E., WILLIAMS, B. H., and SHULKCUM, EDWARD, 1940, Soil survey, Albemarle County, Virginia: U. S. Dept. of Agriculture, Bureau of Plant Industry, Series 1935, No. 14.

- EDMUNDSON, R. S., 1930, Geology of a portion of the Covesville quadrangle in the vicinity of Red Hill, Virginia: M.S. Thesis, University of Virginia.
- ESPENSHADE, G. H., 1954, Geology and mineral deposits of the James River-Roanoke River manganese district, Virginia: U. S. Geol. Survey Bull. 1008, 115 pp.
- FONTAINE, W. M., 1895, On some points in the geology of the Blue Ridge in Virginia: Amer. Jour. Sci. 3rd Series, vol. 9, pp. 15-21.
- , 1883, Contributions to the knowledge of the older Mesozoic flora of Virginia: U. S. Geol. Survey Monograph VI.
- FURCRON, A. S., 1935, James River iron and marble belt, Virginia: Virginia Geol. Survey Bull. 39, 124 pp.
- , 1934, Igneous rocks of the Shenandoah National Park area: Jour. Geol., vol. 42, pp. 400-410.
- GIANNINI, W. F., 1959, A study of the lead-zinc deposit near Faber, Virginia: M.S. Thesis, University of Virginia.
- GOOCH, E. O., 1954, Infolded metasediments near the axial zone of the Catoclin Mountain-Blue Ridge anticlinorium: Ph.D. Thesis, University of North Carolina.
- , 1958, Infolded metasediments near the axial zone of the Catoclin Mountain-Blue Ridge anticlinorium: Geol. Soc. of America Bull. 69, pp. 569-574.
- GRAVATT, C. MARSHALL, 1920, Geologic map of a part of the northeast portion of Albemarle Co., Virginia showing distribution of graphite schist: Virginia Geological Survey.
- HEINRICH, O. J., 1879, Mesozoic formations in Virginia: Amer. Inst. Mining Eng. Trans. vol. 6, pp. 227-274.
- HESS, H. H., 1933, Hydrothermal metamorphism of an ultrabasic intrusive at Schuyler, Virginia: Am. Jour. Sci., 5th ser., vol. 26, No. 154, pp. 377-408.
- HOTCHKISS, MAJOR JED, 1876, Virginia, embracing a description of the state, its geology, soils, minerals, etc: Richmond. 319 pp. and maps.
- , 1885, New brown stone quarry in Virginia: The Virginias, vol. 6, p. 16.
- JEFFERSON, THOMAS, 1787, Notes on Virginia: vol. II, p. 6.
- JONAS, A. I., 1927, Geologic reconnaissance in the Piedmont of Virginia: Geol. Soc. America Bull., vol. 38, no. 4, pp. 837-946.
- , 1929, Structure of the metamorphic belt of the central Appalachians: Geol. Soc. America Bull. vol. 40, no. 2, pp. 503-513.

- , 1935, Hypersthene granodiorite in Virginia: *Geol. Soc. America Bull.*, vol. 46, no. 1, pp. 47-60.
- JONAS, ANNA I. and STOSE, GEO. W., 1936, Age reclassification of the Frederick Valley (Md. limestones: *Geol. Soc. America Bull.* vol. 47, pp. 1657-1674.
- , 1939, Age relations of the Precambrian rocks in the Catoctin Mountain-Blue Ridge and Mount Rogers anticlinoria in Virginia: *Am. Jour. Sci.*, vol. 237, No. 8, pp. 575-593.
- KEITH, A. and GEIGER, H. R., 1891, *Geol. Soc. America Bull.*, vol. 2, pp. 155-164.
- KEITH, ARTHUR, 1894, Geology of the Catoctin Belt: U. S. Geol. Survey, Fourteenth Ann. Rept., pt. 2, pp. 285-395.
- , 1894, Harpers Ferry Folio: U. S. Geol. Survey, no. 10.
- , 1903, Cranberry Folio: U. S. Geol. Survey, no. 90.
- KING, P. B., 1950, Tectonic framework of southeastern United States; *Am. Assoc. Petrol. Geol. Bull.*, vol. 34, no. 4, pp. 635-671.
- , 1954, The Geology of the Elkton area: U. S. Geol. Survey Professional Paper 230.
- KINGERY, THOMAS LEROY, 1954, Scottsville Triassic basin: M.S. Thesis, University of Cincinnati.
- LAMBETH, W. A., 1901, Notes on the geology of the Monticello area, Virginia: Ph.D. Thesis, University of Virginia.
- LANE, A. C., April 1935, Report of the committee on the measurements of geologic time: National Research Council Annual Meeting, p. 39.
- LEWIS, MORDECAI, 2nd., 1926, Geology of the Catoctin belt in the vicinity of Charlottesville, Albemarle County, Virginia: M.S. Thesis, University of Virginia.
- MACK, TINSLEY, 1957, Geology of the Everona formation: M.A. Thesis, University of Virginia.
- MACLURE, WILLIAM, 1817, Observations on the geology of the United States of America with some remarks on the effect produced on the nature and fertility of soils by the description of the different classes of rocks: Abraham, Small, 112 Chestnut Street, Philadelphia.
- McKEE, EDWIN D., and others, 1959, Paleotectonic maps of the Triassic system: Washington, U. S. Geol. Survey. (Miscellaneous geologic investigations (map I-300).
- MERTIE, J. B., JR., 1956, Paragneissic formations in northern Virginia: (Abs.) *Geol. Soc. America Bull.* vol. 67, pp. 1754-55.

- MOORE, F. H., 1931, Geology of a portion of the Piedmont in the vicinity of Carter Bridge, Virginia. M.A. Thesis, University of Virginia.
- NELSON, WILBUR A., 1932, Rockfish conglomerate, Virginia: Jour. Washington Acad. Sci., vol. 22, no. 15, pp. 456-457.
- , 1940, Topography of the former continent of Appalachia (from geologic evidence): Transactions of 1940 of the American Geophysical Union. pp. 786-796.
- , 1954, Notes on the structure of the Virginia Piedmont: Geol. Soc. America Bull. vol. 65, p. 1365 (abst.).
- NEWHOUSE, W. H., 1933, Mineral Zoning in the New Jersey, Pennsylvania, Virginia Triassic area: Econ. Geol., vol. 28, pp. 613-633.
- REDFIELD, W. C., 1856, Newark formation: Amer. Jour. Sci. 2nd Series, vol. 22, p. 357.
- REED, J. C., JR., 1955, Catoctin formation near Luray, Virginia: Geol. Soc. America Bull. vol. 66, no. 7, pp. 871-896.
- RIES, H. and SOMERS, R. E., 1917, The clays of the Piedmont province, Virginia: Virginia Geol. Survey Bull. no. 13.
- ROBERTS, J. K., 1928, The geology of the Virginia Triassic: Virginia Geol. Survey Bull. 29. 205 pp.
- RODGERS, J., 1952, Absolute ages of radioactive minerals from the Appalachian region: Am. Jour. Sci., vol. 250, no. 6, pp. 411-427.
- ROGERS, W. B., 1884, A reprint of annual reports and other papers on the geology of the Virginias: New York, C. Appleton and Co. 832 pp. (Reports originally published, 1835-1841)
- STOSE, GEO. W., 1928, Editor, Geologic Map of Virginia: Virginia Geol. Survey, Wilbur A. Nelson State Geologist.
- STOSE, ANNA I. and STOSE, GEO. W., 1946, The physical features of Carroll county and Frederick county, Maryland: Dept. of Geol. Mines and Water Resources, State of Maryland. 18 pp.
- STOSE, ANNA I., 1954, Personal communication. Fucoids in Catoctin greenstone near Zebulon, North Carolina.
- SUTHERLAND, M. Y., JR., A comparative study of the Virginia granites. M.S. Thesis, University of Virginia.
- TAZELAAR, J. F., 1958, A geological and geophysical survey of Stony Point, Virginia, iron-copper deposit. M.A. Thesis, University of Virginia.
- TILTON, G. F., WETHERILL, G. W., DAVIS, G. A., BASS, M. N., 1960, 1,000 million year old minerals from the eastern United States and Canada: Jour. Geophysical Research, vol. 65, no. 12, pp. 4173-4179.

- VERNON, R. C., 1952, Geology of the Crozet-Pastern Fence Mountain area, Albemarle County, Virginia: M.S. Thesis, University of Virginia.
- WATSON, T. L., 1907, Mineral Resources of Virginia: Virginia Jamestown Exposition Commission, Lynchburg, Virginia. 618 pp.
- WILLIAMS, G. H., and CLARK, W. B., 1893, Maryland, its resources, industries and institutions: Dept. of Geol. Mines and Mineral Resources, Maryland. 68 pp.
- WOODS, REV. EDGAR, 1932, Albemarle County in Virginia: The Green Bookman, Bridgewater, Virginia.
- WOODWARD, H. P., 1957, Chronology of Appalachian folding: Am. Assoc. Petrol. Geol. Bull. vol. 41, no. 10, p. 2325.

INDEX

	PAGE		PAGE
Advance Mills	38	Bucks Elbow Mountain	6, 17, 25, 62
Afton	5, 11	Bucks Mountain Creek	55
Age determinations	16, 35, 36	Building stones	65
Alaskite	37	Burnleys	38, 41, 70
Alberene	42, 64, 76		
Alberene soapstone	76	Calf Mountain	25, 48
Albemarle Zinc & Lead Co.	78	Cambrian and Precambrian contact ..	35
Amethysts	64	Cambrian or Precambrian system	22
American-Marietta Co.	67	Cambrian system	30
Ammonett	38	Campbell	70
Amphibolite	37, 42, 83	Carter Bridge	5, 26, 37
Amygdaloids	24, 25	Carter Mountain	6, 24, 30, 32, 70
Analysis of ore	69	Catoctin formation	24, 82
Angular unconformity	36, 46, 53	Charlottesville	4, 6, 8, 11, 15, 18, 19,
Anticlinorium	1, 43, 45, 53	20, 21, 22, 24, 26, 37, 38, 39, 41,	
Antietam formation	30	45, 46, 47, 48, 49, 50, 52, 54,	
Appalachian revolution	62, 63	56, 60, 61, 63, 64, 65, 74, 81, 82	
Applebury granite	15	Charlottesville formation	22, 81
Asbestos	64	Charlottesville Sand & Gravel Co.	74
Ash Lawn	26, 64	Charlottesville Stone Co.	27, 66, 67
Augen gneiss	16, 55	Cismont	5, 27
		Clay	64, 65
Barboursville	5, 7, 32, 33, 45, 52	Cobham	69
Barite	64	Columnar jointing	25, 26
Basement complex	3, 11	Cook Mountain	8, 10, 69
Batesville	53, 67	Cook Mountain magnetite deposit	69
Bear Creek	15	Copper mine	41, 66
Bethel Church	39	Copper ore	66
Black Rock Mountain	30, 31, 55	Cove Creek	39
Blenheim	30	Covesville	15
Blue Ridge Mountains	4, 5, 6, 8, 11,	Cox slate quarry	75
23, 25, 28, 29, 30, 31, 35, 39,		Crozet	4, 6, 23, 39, 64, 80, 81
43, 44, 48, 50, 57, 58, 60, 61,		Crozet granite	15, 17
62, 63, 81		Crozet Station	65
Blue Ridge Parkway	25, 26	Crushed stone	66
Blue Ridge Slate Corp.	75	Culpeper basin	2, 33
Boonesville	81		
Border fault	48	Damon	76
Boyd's Tavern	39	Dawson Mill	27, 63
Brick	64, 65	Diabase dikes	38, 83
Brick clays	64, 65	Dikes	37
Brown stone quarry	65	Drag folds	47
Browns Gap	25, 29, 48	Dudley Mountain	15, 67
Brownsville	65		
Buck Island Creek	30, 31, 71	Earlsville	38
Buck Mountain	55	Eastham	24, 26

	PAGE		PAGE
Erwin quartzite	30	Harpers shale	30
Esmont	30, 41, 75	High angle reverse faults	48, 50
Esmont slate	75	High angle thrust faults	48, 50
Everona limestone	31, 83	High Top Mountain	40
Everona syncline	46	Howardsville	63, 65
Faber	15, 18, 19, 60, 67, 78	Hydraulic	41, 74
Faldband	21	Hydraulic Company	74
False cleavage	56	Hydrothermal alterations	42, 76, 77
Fan Mountain	79	Iron ore	69
Fanglomerate	33, 41	Israel Gap	15
Faults	47	Ivy	11, 67
Feeder dikes	40	James River	4, 5, 6, 7, 8, 32, 39, 83
Feldspar phenocrysts	16, 17, 25	Jarmans Gap	22, 25, 29, 62
Felsite	40, 65, 66	Johnson Mill	21, 37, 45
Flandevare River	33	Johnson Mill formation	21, 81
Fluorspar	67	Joints	57
Forest Hill	75	Keen	33, 34
Fox Mountain	6, 23, 40, 44, 62	Keswick	26, 27, 30, 61, 64, 75, 83
Fracture cleavage	55, 56	Lead, see zinc and lead	
Free Union	81	Lebanon Church	51, 63
Free Union School	81	Limestone	31, 32, 62, 70, 71
Gabbro	41	Limestone Creek	30, 39, 61, 75
Garnets	67	Limestone quarries	70
Geophysical work	10, 69, 72, 73	Lindsey Station	70
Georgia Marble Co.	76	Loft Mountain	6, 48
Geosyncline	62	Loudoun formation	28, 82
Gibson Mountain	40	Lovingsston gneiss	11
Gilbert	61	Lynchburg formation	19
Gilbert Station	21	McCullough	27
Glendower	33, 41, 83	Magnetic surveying	69, 72, 73
Gneissic structure	55, 67	Magnetite	69, 77
Gold	67	Magnetite crystals	23
Gordonsville	7	Marble	8
Gossan ore	70	Martins Mountain	40
Graben	11, 24, 44, 53	Mayo Chapel	42
Granite	15	Mechum Creek	70
Graphite	21, 60, 71	Mechum River 15, 38, 40, 43, 45, 53, 63	
Graphite mine	3, 67, 71	Mechum River formation	24, 81
Graphite schist	21, 45	Mechum River graben	11, 53
Green Mountain	6, 24, 30, 76	Metapyroxenite	42
Greenstone conglomerate	26, 27	Midway Mill	65
Greenwood	50, 51	Mill Creek	21
Ground water	80	Miller School	11, 39
Hampton shale	30	Millington	16, 55
Hardware River	7, 21, 27, 33, 38, 63, 71, 83		

	PAGE		PAGE
Mont Fair	39, 40	Schuyler	22
Monticello	26, 37, 61	Scott Mountain	25
Monticello Brick Co.	64	Scottsville	4, 5, 6, 32, 33, 55, 58, 83
Moormans River	16, 17	Scottsville Basin	34
Mount Alto Church	27	Sericite schist	21, 23
Mount Olivet School	38, 53	Shadwell	11, 26, 27, 30, 47, 57, 64, 66, 67
Mount Zion Church	33, 34	Sharp Top Mountain	24, 53
Mullion structure	56	Shear zone	56, 63, 67
Naylor Mountain	67	Shenandoah Nat'l Park	25, 29
Newark formation	32	Shenks Branch	22
Normal fault shear zone	56	Simeon	30, 37, 47, 54, 64
Normal faults	51, 52, 53, 56	Skyline Drive	5, 25, 29, 31, 40, 48, 55
North Anna River	7	Slate	75
North Garden	8, 10, 21, 69	Slaughter Pen Creek	39
Nortonsville	16	Soapstone	76
Ohio Sulphur Mining Co.	21, 71, 72	South Anna River	7
Olds iron furnace	8, 69	South Garden	15, 38
Overton	26, 30	Southwestern Mountain	5, 6, 8, 11, 23, 24, 26, 27, 28, 29, 30, 32, 37, 38, 40, 42, 43, 46, 47, 57, 61, 63, 66, 67, 70, 82
Paragneiss	11, 16	Southwestern Mountain-Blue Ridge anticlinorium	43, 46
Pasture Fence Mountain	6, 17, 25, 54	Specular hematite	70
Pegmatite granite	15	Stillhouse Mountain	19
Pigeon Top Mountain	39, 81	Stockton Creek	63
Piney Creek	67	Stony Point	37, 66, 70
Piney Mountain	11, 20, 38, 48	Stony Point mine	41, 70
Pleistocene	50, 51, 63	Sugar Hollow	22
Powell Corner	61	Superior Stone Co.	67, 68
Priddy Creek	33, 66	Swift Run formation	22, 80, 82
Proffit	10, 21, 60, 71, 72, 73, 75		
Pyrite	45, 71		
Quartz	23, 46		
Ragged Mountains	6	Taconic revolution	38, 62
Red Hill	15, 53, 67, 68	Terrace gravel	50, 51, 63
Redbud Creek	24	Toms Mountain	39
Reverse faults	47, 48	Triassic areas	33, 83
Rich Cove Creek	38	Triassic rocks	32
Rivanna River	6, 7, 8, 25, 26, 32, 38, 57, 60, 66, 81	Trinity Church	15
Rockfish conglomerate	17		
Rockfish Gap	8, 25, 26, 28, 29, 39, 61	Unakite	17
Rockfish River	7, 8, 32, 33, 48	Unconformities	53
Rugby Station	30	Underthrust faulting	50
		Unicoi	28
		University amphibolite dikes	37, 45, 51
Sand	74		
Schistosity	55	Virginia Blue Ridge complex	15, 23, 80
		Water	59

	PAGE		PAGE
Watts Station	22	Woodbridge School	70
Wesley Chapel	39, 40	Yancey Mills	57, 58
Weverton formation	28	Yellow Mountain Creek	57
Whitehall	16		
Williamson, S. W., Inc.	74	Zinc and lead deposits	78